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Preliminary Report on the 1992 Lake Hartwell/

Twelve Mile Creek Recreational Angler Surveys

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Introduction

High levels of polychlorinated biphenyls (PCBs) were detected in the flesh of fishes collected from Lake Hartwell in 1976 by the South Carolina Department of Health and Environmental Control (SCDHEC) and the United States Environmental Protection Agency (EPA). Sangamo Weston, Inc. of Pickens, South Carolina used PCBs at their capacitor production facility and PCBs were discharged by their wastewater treatment plant effluent into Town Creek, a tributary of Twelve Mile Creek (Gaymon 1982). Discharge of PCBs by Sangamo Weston, Inc. occurred from the mid-1950s and until halted in fall 1977 by SCDEHEC and EPA.

In fall 1976, SCDHEC and EPA issued a public health advisory which warned the public not to eat fish taken from the Seneca River arm of Lake Hartwell (north of S.C. Hwy 24 bridge). The advisory was modified in 1985 and further warned the public not to eat fish >3 lbs. throughout Lake Hartwell. This resulted from a decrease in the safe consumptive tolerance level of PCBs from 5 ppm to 2 ppm by the United States Food and Drug Administration (USFDA) (Gaymon 1988). This health advisory has remained in effect since 1985.

Recreational angler use of Lake Hartwell was monitored by roving creel surveys from 1980-1982 and in 1988 and 1989 by the South Carolina Wildlife and Marine Resources Department (SCWMRD) (Self 1991). These roving creel surveys provided estimates of angler effort, harvest rates and catch rates of gamefish species.

Recreational angler use of Twelve Mile Creek had never been documented. Roving creel surveys were initiated in January 1992 on Lake Hartwell and Twelve Mile Creek by the SCWMRD as part of the biological investigations required for Remedial Investigation/Feasibility Study at the Sangamo Weston, Inc./Twelve Mile Creek/Lake Hartwell PCB Contamination Superfund Site Operable Unit Two. In addition to angler effort, harvest rates and catch rates, these surveys were designed to investigate anglers' monetary expenditures, anglers' fish consumption habits and anglers' awareness of the current health advisory.

Methods

These roving creel surveys were designed with nonuniform probabilities and a stratified random sampling design described by Malvestuto et al. (1978). Stratified random sampling reduces sampling variance by controlling variability in the parameter being estimated (Malvestuto 1983). The creel surveys were designed in consultation with Fishery Information Management Systems, Inc. (FIMS) in Auburn, Alabama. Probabilities assigned to the Lake Hartwell creel survey parameters were based on review of historic creel data. The probabilities assigned to Twelve Mile Creek creel survey parameters were considered equal due to lack of historic data.

The sample period (January-December) for the Lake Hartwell creel survey was divided into four blocks: winter (January-

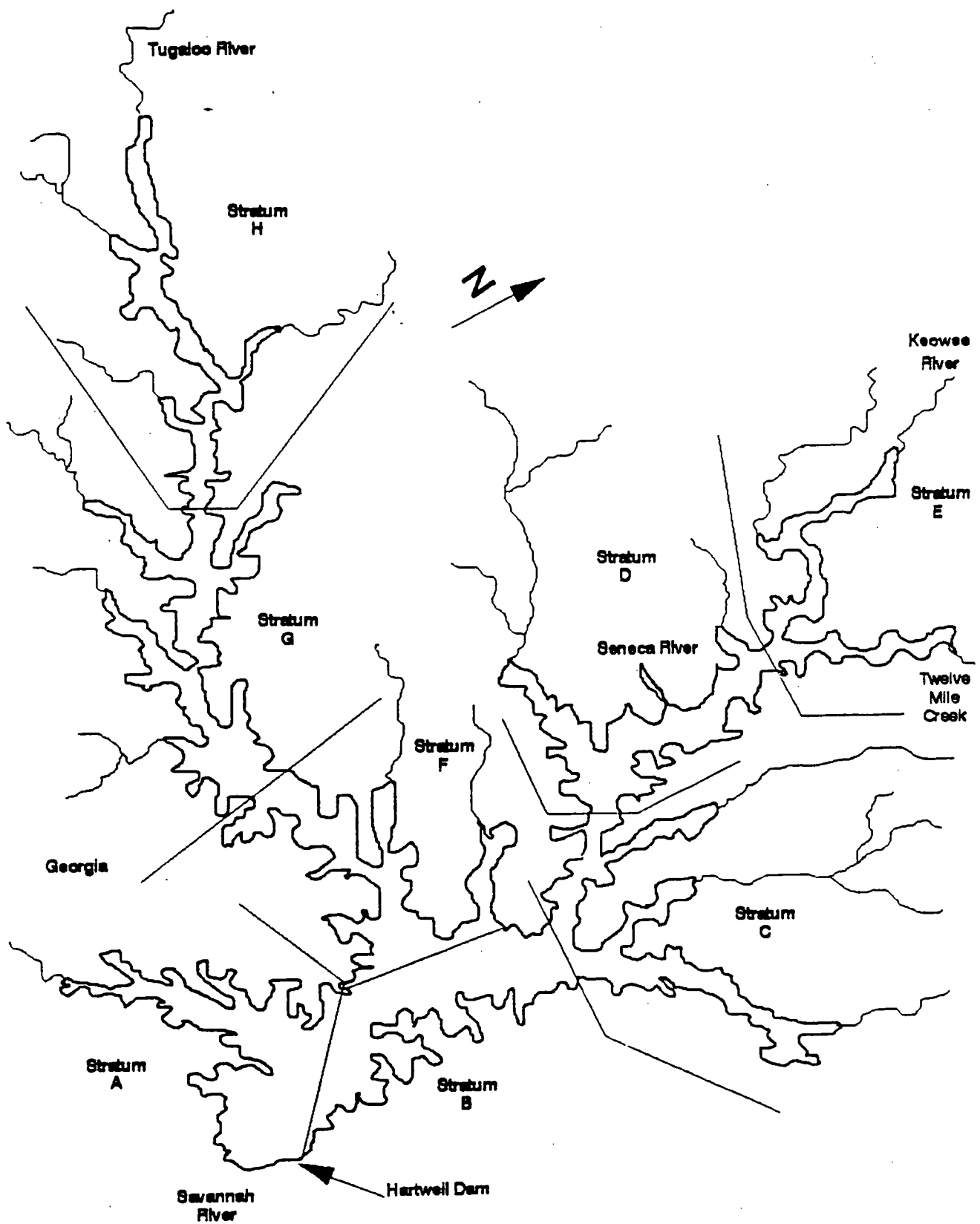


Figure 1. Geographical strata surveyed during the 1982 roving creel survey on Lake Hartwell.

March), spring (April-June), summer (July-September), and fall (October-December). Thirty-two surveys were conducted in each block for a total of 128 sample days. Fifty percent of the sample days were weekdays and fifty percent were weekend days.

Dates, times and lake strata were randomly selected for each block. Time consisted of three 4-hour periods: 1) AM (6:00AM-10:00AM), 2) Noon (10:00AM-2:00PM) and 3) PM (2:00PM-6:00PM). Each time period was assigned a probability of 0.3333. Lake Hartwell was divided into eight geographical strata which allowed evaluation of angler use relative to spatial PCB concentrations in fish flesh and in sediment samples (Figure 1). Each of the eight strata were sampled four times within each block.

Surveys were conducted within each lake stratum by making either a right or left circuit, determined by coin toss. All anglers were counted and as many interviews were conducted as possible while the creel clerk allotted sufficient time to complete a full circuit of the sample area. When possible, fish in the anglers' creels were measured (TL=inch group) to obtain length frequency data. These TL values were later converted to weights (lbs) with species-specific length-weight regression equations developed by SCWMRD. In addition, anglers were asked a series of questions including time spent fishing, residence, monetary expenditures, and a range of fish consumption questions including frequency of fish consumption, how many fish were needed to make a meal, whether they were eaten whole or filleted,

how many people ate fish at a meal and how many meals were eaten of fish caught from Lake Hartwell in one month (Appendix Figure A1).

Per capita fish consumption estimates and associated RSEs were calculated for anglers not interviewed previously that indicated they ate fish from Lake Hartwell:

$$N_{Total} = \sum N_i$$

N_{Total} = total number of fish harvested

N_i = number of fish harvested by interview

$$WT_{Int} = \sum WT_{Harv} * 0.5_F \quad \text{or} \quad WT_{Int} = \sum WT_{Harv} * 0.7_W$$

WT_{Int} = sum of weight of fish harvested

WT_{Harv} = sum of weight of fish harvested by interview

0.5_F = dress-out percentage of filleted fish

0.7_W = dress-out percentage of whole fish

$$WT_{Ave} = WT_{Int} / N_{Total}$$

$$WT_{Total} = WT_{Sum1} + WT_{Sum2}$$

$WT_{Sum1} = WT_{Int}$ (If fish were to be eaten at next meal)

$$WT_{Sum2} = WT_{Int} + (N_{Eat} * WT_{Ave})$$

N_{Eat} = number of fish needed to make a meal

$$\text{Per_meal} = \text{WT}_{\text{Total}} / N_{\text{People}}$$

Per_meal= weight of fish consumed at each meal

N_{People} = number of people who will eat fish at the meal

$$\text{Per_cap} = \text{Per_meal} / N_{\text{Meal}}$$

Per_cap= consumption per capita for all meals in 1 month

N_{Meal} = number of meals eaten of fish in 1 month

Mean per capita and associated RSE values were calculated for each stratum in each seasonal block. Mean per capita values for each stratum were combined to calculate a mean per capita consumption value for each seasonal block.

The sample period for the Twelve Mile Creek creel survey was divided into monthly blocks (January-December). Blocks January-March and October-December were surveyed four times per block and blocks April-September were surveyed nine times per block for a total of 78 sample days. The additional surveys in April-September were used to provide more creel data, as angler use was expected to increase during the more temperate months. Survey design was modified to accept these additional creel samples.

The time periods consisted of two 6-hour periods, 6:00AM-12:00PM (AM) and 12:00PM-6:00PM (PM), which were assigned equal probabilities of 0.5000. The area of Twelve Mile Creek surveyed contained thirteen access points that consisted of state and county road bridges (Figure 2). Reconnaissance of Twelve Mile

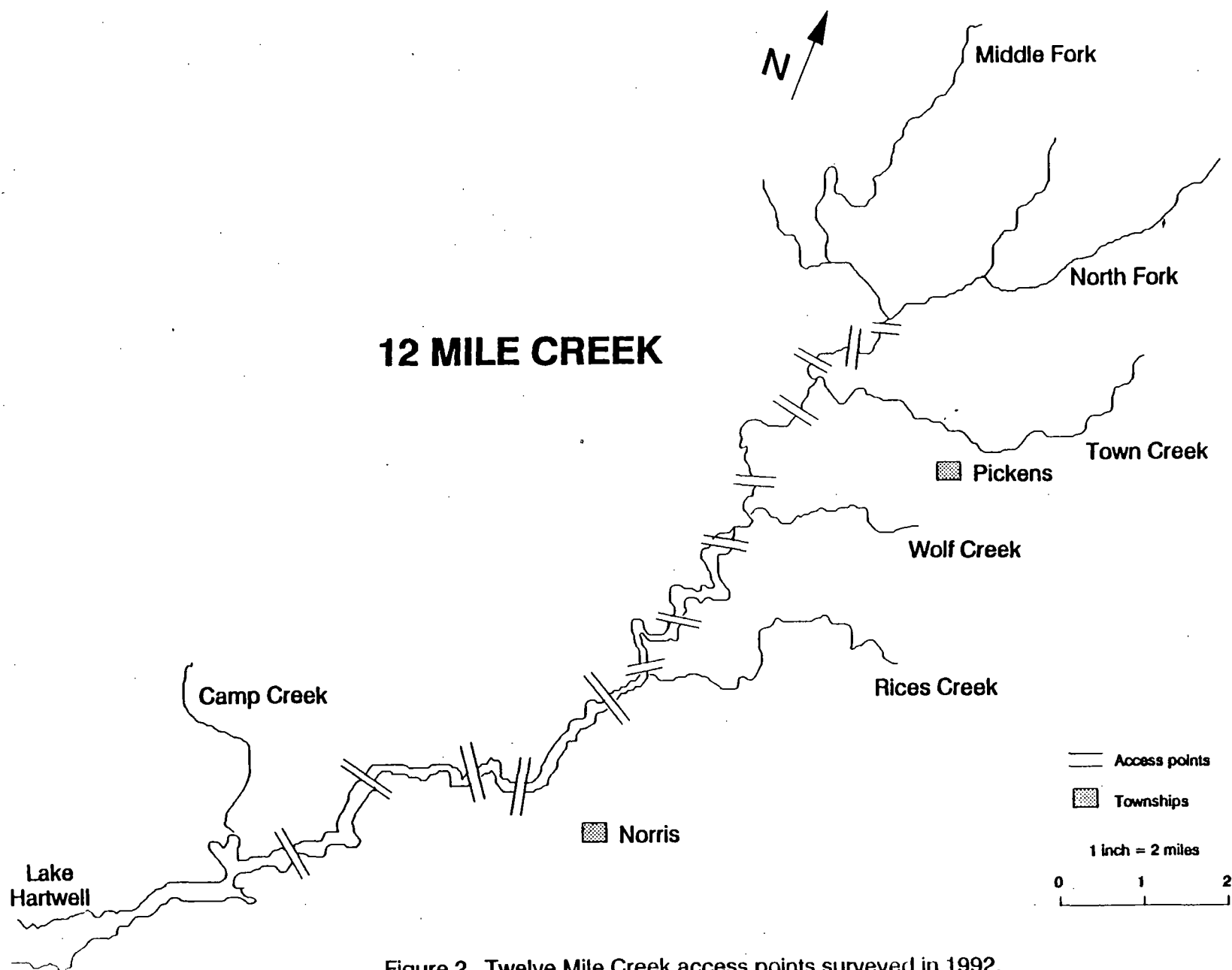


Figure 2. Twelve Mile Creek access points surveyed in 1992.

Creek by project personnel via canoe indicated the majority of recreational angling occurred at these access points. This was due to lack of access to private lands which encompasses most of the Twelve Mile drainage.

Creel sample dates, times, starting points and direction of travel (upstream/downstream) were randomly selected for each block. Upstream or downstream travel allowed for all access points to be sampled at different times over the study period. The shortest travel route possible was charted which allowed all sites to be surveyed during the 6-hour period. An average of twenty-one minutes were spent at each access point.

Surveys were conducted from the bank. Fish in anglers' creels were measured (TL). Weights (lbs) were estimated with species-specific length-weight regression equations developed by SCWMRD. Anglers were asked the same questions as were anglers interviewed during Lake Hartwell creel surveys. Per capita consumption was calculated for each month and summed for total per capita consumption for the eight-month period.

Data were compiled and analyzed with SAS software (SAS 1988). Statistically valid creel programs designed by FIMS were employed to expand daily creel data to seasonal (Lake Hartwell) and monthly (Twelve Mile Creek) estimates of catch, harvest and release rates. Associated relative standard errors were calculated for estimates where possible. Monetary expenditures, fish consumption habits and health advisory awareness, and

comment data were summarized.

Results

Lake Hartwell

Data were compiled for the first two seasonal blocks of 1992 (winter and spring). Anglers exerted an estimated 487,723 angler-hours of effort during winter and spring 1992 (RSE=10). Stratum G received the highest percentage of angler effort in both winter and spring (Figure 3). Sixty-eight percent of the total effort was exerted by boat anglers (333,915 angler-hours, RSE=12) and thirty-two percent by bank anglers (153,807 angler-hours, RSE=20). Boat anglers comprised $\geq 57\%$ of anglers interviewed in all strata in winter 1992; bank anglers interviewed increased in all but two strata in the spring (Figure 4).

Average daily rates (per angler-hour) of the number of fish caught and released, the number of fish caught, the number of fish harvested and the weight (lb) of fish harvested were higher in spring than winter (Table 1). Anglers generally caught and harvested more fish and harvested more pounds of fish from stratum D in spring and more fish were caught and released from stratum B during spring. All rates for winter in each stratum were generally lower than in spring (Table 2).

Of those 144,925 fish were released (RSE=18) and 135,127

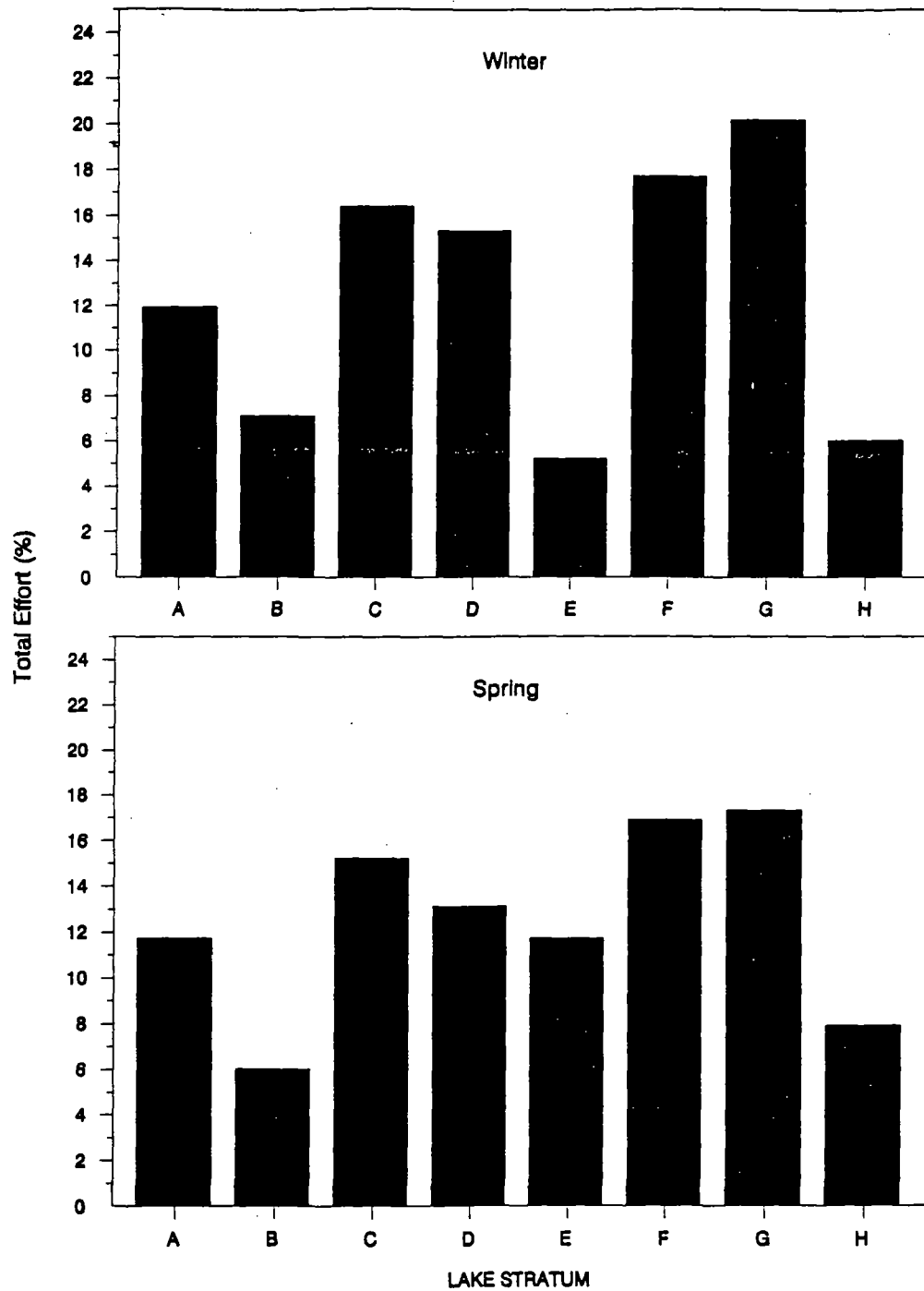


Figure 3. Percent total angler effort (angler-hours) for each geographical stratum in winter and spring 1992 on Lake Hartwell.

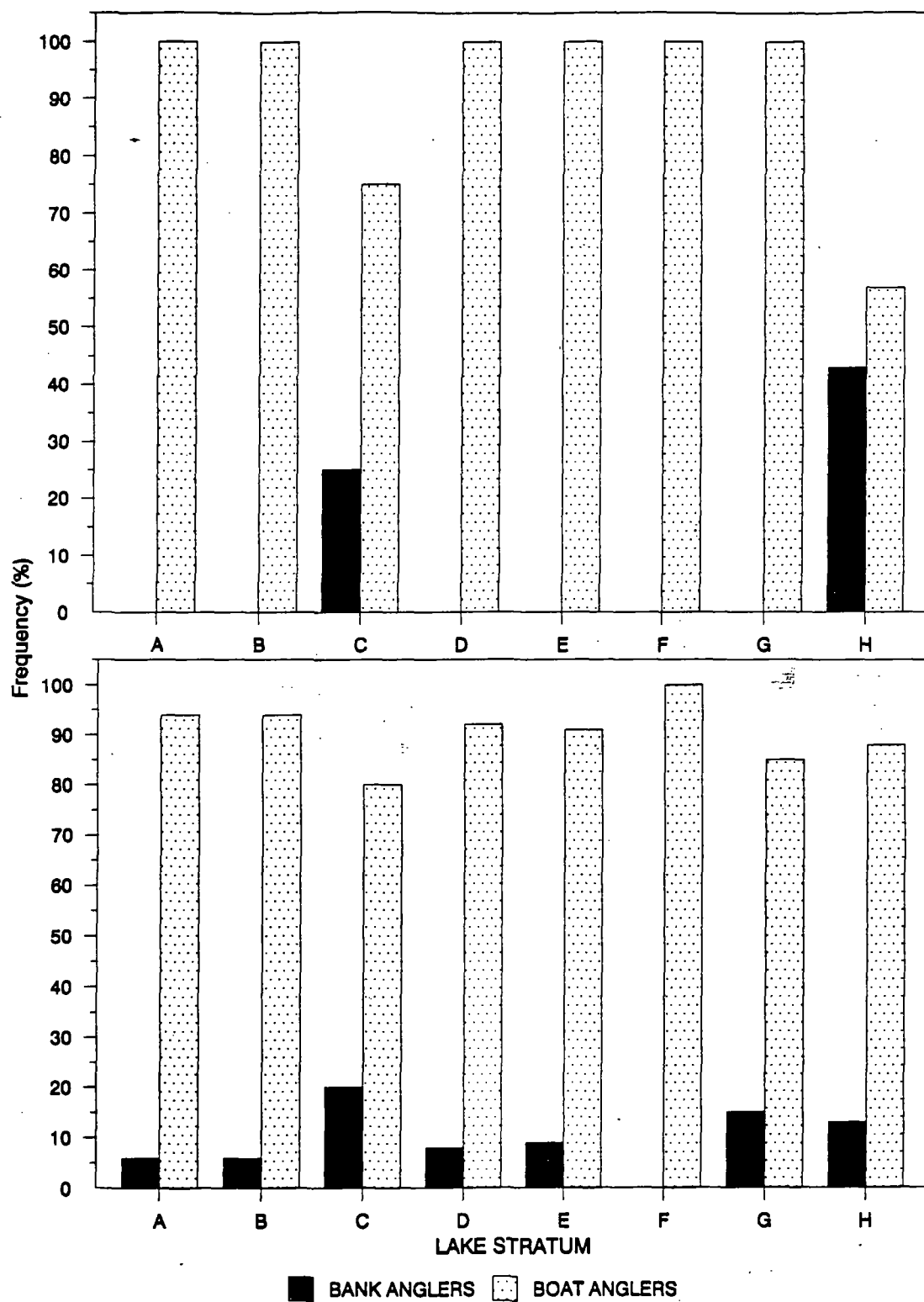


Figure 4. Frequency of bank and boat anglers interviewed in each geographical stratum in winter (top) and spring (bottom) 1992 on Lake Hartwell.

Table 1. Average daily rates (per angler-hour) of number of fish caught and released (C/R), number of fish caught (CATCH), number of fish harvested (HARV) and weight of fish harvested (WT) and associated relative standard errors (RSE) for Lake Hartwell during winter and spring 1992.

<u>Time</u>	<u>C/R</u>	<u>RSE</u>	<u>CATCH</u>	<u>RSE</u>	<u>HARV</u>	<u>RSE</u>	<u>WT</u>	<u>RSE</u>
Winter	.19	14	.39	33	.20	52	.20	44
Spring	.36	9	.68	14	.32	21	.58	31

Table 2. Average daily rates (per angler-hour) of number of fish caught and released (C/R), number of fish caught (CATCH), number of fish harvested (HARV) and weight of fish harvested (WT) and associated relative standard errors (RSE) for each geographical stratum of Lake Hartwell during winter and spring 1992.

<u>Stratum</u>	<u>Time</u>	<u>C/R</u>	<u>RSE</u>	<u>CATCH</u>	<u>RSE</u>	<u>HARV</u>	<u>RSE</u>	<u>WT</u>	<u>RSE</u>
A	Winter	.87	-	.87	-	0	-	0	-
	Spring	.40	30	.73	44	.33	60	.74	54
B	Winter	0	-	0	-	0	-	0	-
	Spring	.59	27	.82	25	.23	21	.37	12
C	Winter	.03	-	.03	-	0	-	0	-
	Spring	.39	33	.63	42	.24	58	.60	62
D	Winter	.05	71	.14	42	.10	28	.22	23
	Spring	.26	41	.84	57	.59	65	2.0	66
E	Winter	.34	61	1.7	62	1.3	62	1.1	60
	Spring	.25	6	.57	12	.32	26	.34	8
F	Winter	0	-	0	-	0	-	0	-
	Spring	.35	15	.59	36	.24	65	.13	59
G	Winter	.23	8	.39	8	.16	32	.22	58
	Spring	.33	1	.74	27	.41	50	.24	49
H	Winter	.01	71	.01	71	0	-	0	-
	Spring	.29	5	.50	10	.21	17	.25	11

fish (RSE=28) weighing 217,192 lbs (RSE=34) were harvested. A total of 280,053 fish were caught (number released+number harvested) (RSE=20). Spring totals in all four categories were higher than winter totals (Table 3). Anglers released the most fish from stratum A, harvested the most fish by number from stratum G, harvested the most fish by weight from stratum D and caught the most fish from stratum G (Figures 5 through 8). Individual values for winter and spring by stratum are listed in Table 4.

Largemouth bass, crappie (black and white crappie combined), striped bass, striped bass x white bass hybrids and channel catfish were the top five species sought by anglers fishing Lake Hartwell in the winter and spring. Forty-eight percent of angler effort was directed toward largemouth bass (Table 5). Largemouth bass comprised the largest percentage by number (45%) as well as by weight (44%) (Table 6 and 7).

Effort targeted for largemouth bass in winter was highest for all lake strata except stratum C where effort targeted for striped bass was highest (Table 8). Anglers that fished stratum C in spring shifted the majority of their effort to largemouth bass (45%) while those in strata D and H shifted the majority of their effort toward crappie (42 and 35%). Effort expended toward striped bass increased in the spring in strata A, B, and E as did effort toward striped bass x white bass hybrids in strata C, D, and E (Table 9).

Table 3. Estimated total number of fish released (REL), total number harvested (HARV), total weight (lbs) harvested (WT), total number caught (number released+number harvested) (CATCH), and associated relative standard errors (RSE) for Lake Hartwell during winter and spring 1992.

<u>Time</u>	<u>REL</u>	<u>RSE</u>	<u>HARV</u>	<u>RSE</u>	<u>WT</u>	<u>RSE</u>	<u>CATCH</u>	<u>RSE</u>
Winter	33,613	16	34,874	53	34,727	45	68,487	34
Spring	<u>111,312</u>	<u>15</u>	<u>100,253</u>	<u>24</u>	<u>182,465</u>	<u>33</u>	<u>211,566</u>	<u>18</u>
Total	144,925	18	135,127	28	217,192	34	280,053	20

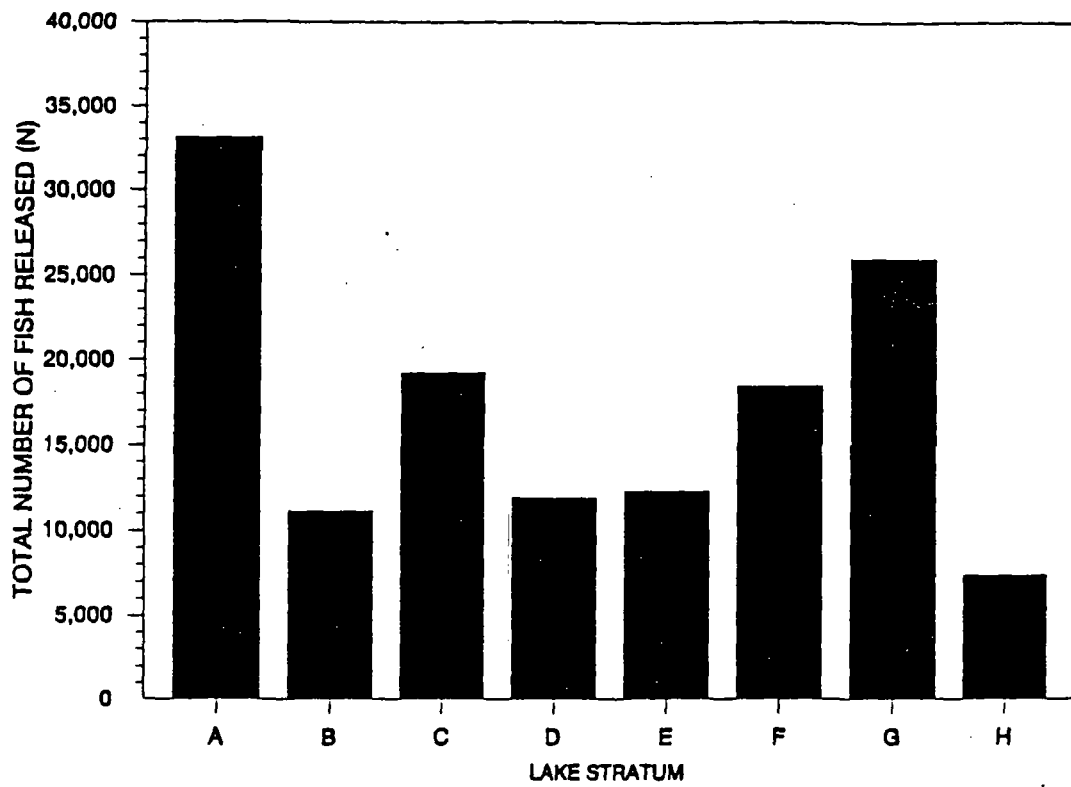


Figure 5. Estimated total number of fish (N) released in each geographical stratum in winter and spring 1992 on Lake Hartwell.

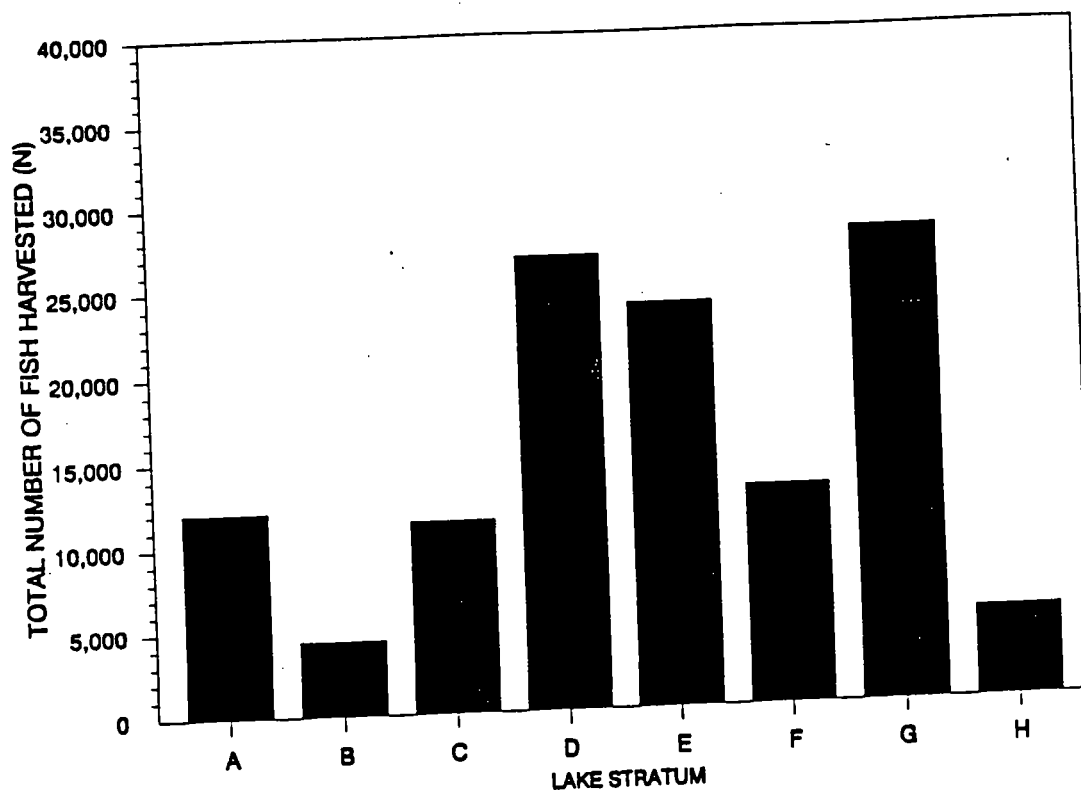


Figure 6. Estimated total number of fish harvested (N) from each geographical stratum in winter and spring 1992 from Lake Hartwell.

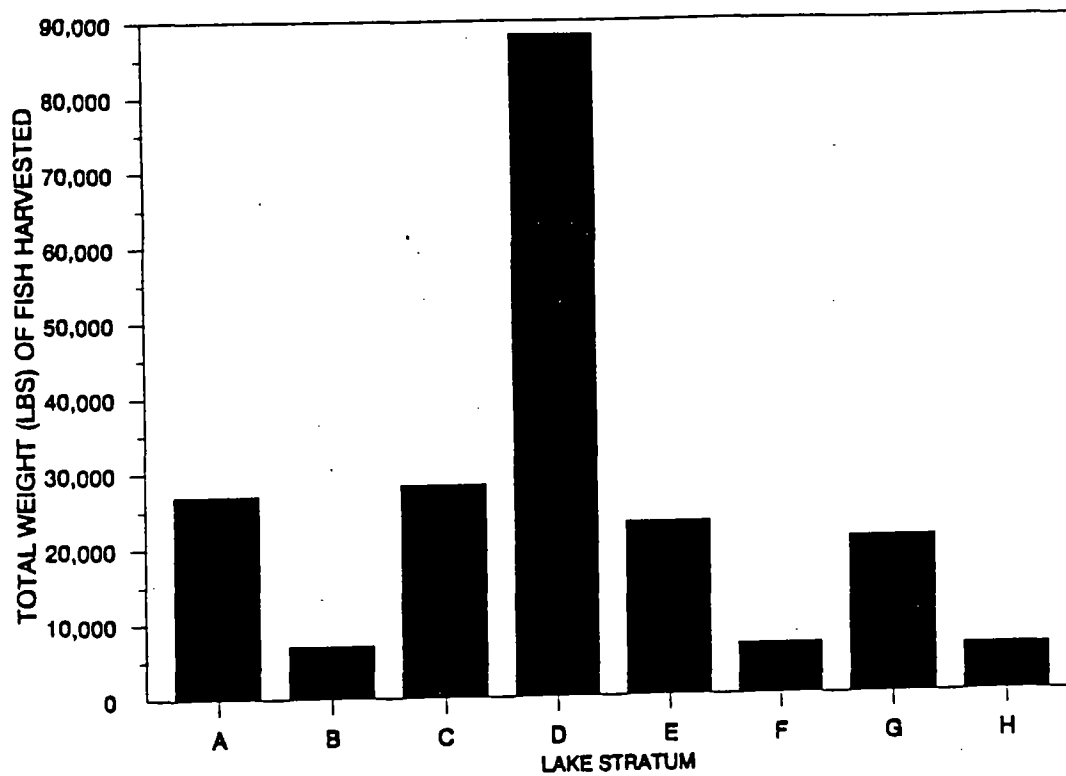


Figure 7. Estimated total weight (lbs) of fish harvested from each geographical stratum in winter and spring 1992 on Lake Hartwell.

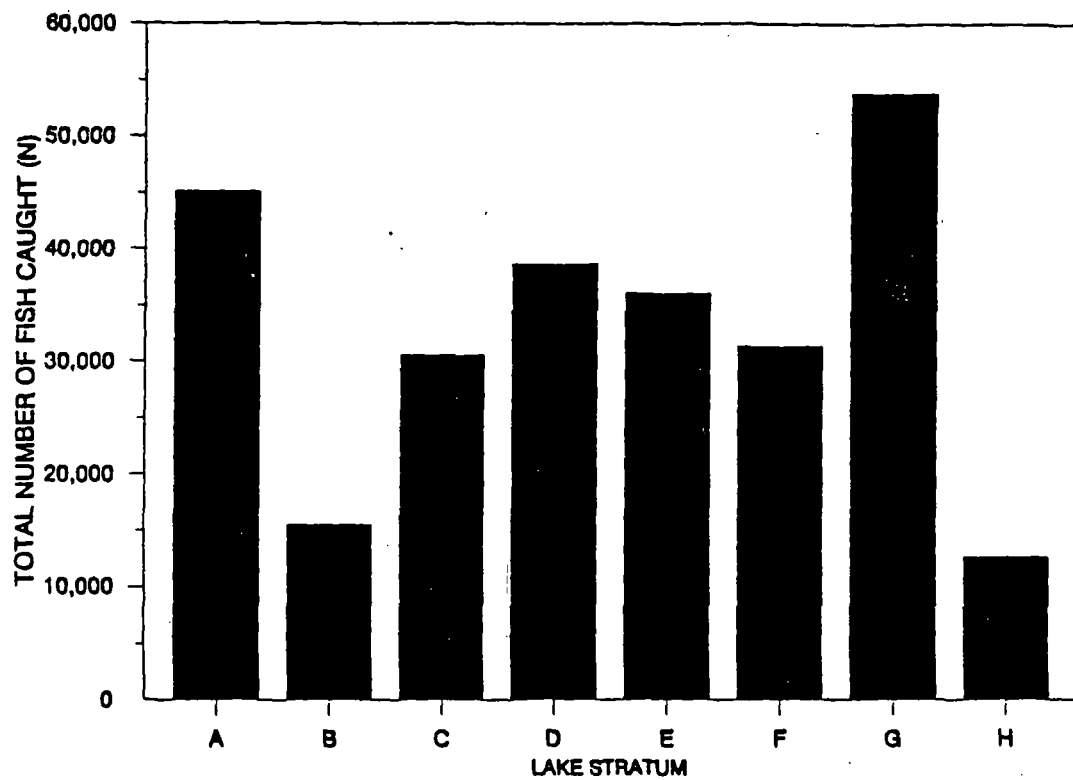


Figure 8. Estimated total number of fish caught (number released+number harvested) from each geographical stratum in winter and spring 1992 from Lake Hartwell.

Table 4. Estimated total number of fish released (REL), total number of fish harvested (HARV), total weight harvested (lbs) (WT) and associated relative standard errors (RSE) for each geographical stratum of Lake Hartwell during winter and spring 1992.

<u>Stratum</u>	<u>Time</u>	<u>REL</u>	<u>RSE</u>	<u>HARV</u>	<u>RSE</u>	<u>WT</u>	<u>RSE</u>
A	Winter	18,421	-	0	-	0	-
	Spring	14,654	32	12,004	61	26,983	55
B	Winter	0	-	0	-	0	-
	Spring	11,078	34	4,377	30	6,985	34
C	Winter	772	-	0	-	0	-
	Spring	18,378	44	11,340	67	28,293	71
D	Winter	1,231	71	2,646	29	5,879	24
	Spring	10,606	46	24,100	68	82,352	70
E	Winter	3,103	68	12,256	69	10,558	67
	Spring	9,115	34	11,513	44	12,524	35
F	Winter	0	-	0	-	0	-
	Spring	18,407	50	12,891	87	6,639	81
G	Winter	8,292	34	5,647	48	7,696	70
	Spring	17,630	25	22,306	57	13,175	56
H	Winter	92	77	0	-	0	-
	Spring	7,229	8	5,236	18	6,267	13

Table 5. Distribution of angler effort (angler-hours)
toward targeted species in winter and spring
1992 on Lake Hartwell.

<u>Species</u>	<u>Time</u>		<u>Total</u>	<u>%</u>
	<u>Winter</u> <u>Angler/</u> <u>hours</u>	<u>Spring</u> <u>Angler/</u> <u>hours</u>		
Anything	3,685	47,967	51,652	12
Bluegill	0	20,812	20,812	5
Crappie	9,648	40,826	50,474	12
Channel catfish	2,131	13,422	15,553	4
Carp	0	841	841	<1
Largemouth bass	71,834	128,569	200,403	48
Spotted bass	0	592	592	<1
Striped bass	33,017	7,242	40,259	10
Striped bass x white bass hybrids	5,945	28,161	34,106	8
Walleye	2,675	0	2,675	<1
White bass	0	2,459	2,459	<1

Table 6. Estimated total harvest (N) and percent composition (%) by species of fish harvested by anglers from Lake Hartwell in winter and spring 1992.

Species	Time		Spring		Total	%
	Winter		N	%		
	N	%	N	%		
Brown bullhead	0	0	393	<1	393	<1
Bluegill	0	0	5,897	6	5,897	4
Channel catfish	0	0	2,359	2	2,359	2
Crappie	6,850	20	17,299	17	24,149	18
Largemouth bass	23,042	66	38,136	38	61,178	45
Redeye bass	0	0	1,573	2	1,573	1
Redear sunfish	0	0	1,966	2	1,966	1
Spotted bass	0	0	786	<1	786	<1
Striped bass	1,246	4	8,256	8	9,502	7
Striped bass x white bass hybrids	1,868	5	20,444	20	22,312	17
White bass	0	0	2,359	2	2,359	2
White catfish	0	0	786	<1	786	<1
Yellow perch	1,246	4	0	0	1,246	1

Table 7. Estimated weight (lbs) by species of fish
harvested by anglers from Lake Hartwell in winter
and spring 1992.

Species	Time		Spring		Total	%
	Winter lbs	%	lbs	%		
Brown bullhead	0	0	226	<1	226	<1
Bluegill	0	0	971	<1	971	<1
Channel catfish	0	0	1,774	1	1,774	<1
Crappie	4,035	12	8,958	5	12,993	6
Largemouth bass	23,942	69	71,524	39	95,466	44
Redeye bass	0	0	1,484	<1	1,484	<1
Redear sunfish	0	0	953	<1	953	<1
Spotted bass	0	0	213	<1	213	<1
Striped bass	3,380	10	14,792	8	18,172	8
Hybrid-striped bass	3,120	9	78,070	43	81,190	37
White bass	0	0	2,644	1	2,644	1
White catfish	0	0	855	<1	855	<1
Yellow perch	216	<1	0	0	216	<1

Table 8. Angler effort (angler-hours) and associated percentages directed toward targeted species for each geographical lake stratum of Lake Hartwell in winter 1992.

<u>Time</u>	<u>Stratum</u>	<u>Target Species</u>	<u>Hours</u>	<u>%</u>
Winter	A	Largemouth bass	14,167	75
		Striped bass x white bass hybrids	4,722	25
	B	Anything	1,018	11
		Largemouth bass	7,893	89
	C	Crappie	947	4
		Largemouth bass	4,428	15
		Striped bass	23,428	81
	D	Largemouth bass	15,386	75
		Striped bass	5,004	25
	E	Crappie	4,880	55
		Largemouth bass	4,007	45
	F	-----	--	--
	G	Anything	1,720	5
		Crappie	2,751	9
		Largemouth bass	25,952	80
		Striped bass	1,376	4
		Striped bass x white bass hybrids	688	2
	H	Anything	947	7
		Channel catfish	2,131	16
		Crappie	1,070	11
		Striped bass	3,209	33
		Striped bass x white bass hybrids	535	6
		Walleye	2,675	27

Table 9. Angler effort (angler-hours) and associated percentages directed toward targeted species for each geographical lake stratum of Lake Hartwell in spring 1992.

<u>Time</u>	<u>Stratum</u>	<u>Target Species</u>	<u>Hours</u>	<u>%</u>
Spring	A	Anything	824	2
		Bluegill	9,127	25
		Crappie	1,007	2
		Largemouth bass	14,895	41
		Striped bass	2,014	6
		Striped bass x white bass hybrids	8,561	24
	B	Anything	4,421	24
		Channel catfish	5,851	31
		Crappie	197	1
		Largemouth bass	7,664	41
		Striped bass	590	3
	C	Anything	6,107	13
		Bluegill	1,893	4
		Channel catfish	6,557	14
		Carp	841	2
		Crappie	148	<1
		Largemouth bass	21,272	45
		Spotted bass	592	1
		Striped bass x white bass hybrids	9,862	21
	D	Anything	9,456	23
		Crappie	17,072	42
		Bluegill	634	2
		Largemouth bass	9,257	23
		Striped bass	3,001	7
		Striped bass x white bass hybrids	1,691	4
	E	Anything	3,341	9
		Bluegill	9,157	25
		Crappie	4,348	12
		Largemouth bass	13,592	37
		Striped bass	1,364	4
		Striped bass x white bass hybrids	4,705	13

Table 9 (cont.). Angler effort (angler-hours) and associated percentages directed toward targeted species for each geographical lake stratum of Lake Hartwell in spring 1992.

<u>Time</u>	<u>Stratum</u>	<u>Target Species</u>	<u>Hours</u>	<u>%</u>
Spring	F	Anything	2,345	8
		Crappie	1,693	5
		Largemouth bass	27,789	87
	G	Anything	17,327	32
		Crappie	7,603	14
		Largemouth bass	28,498	53
		Striped bass x white bass hybrids	610	1
	H	Anything	4,146	17
		Channel catfish	1,014	4
		Crappie	8,657	35
		Largemouth bass	5,602	23
		Striped bass	273	1
		Striped bass x white bass hybrids	2,733	11
		White bass	2,459	10

Catch-per-unit-effort (CPUE) (number released+number harvested) was highest in spring for the top five targeted species (Table 10). Largemouth bass and crappie comprised the largest percentage by number of fish harvested for strata D, E and G in winter (Table 11). Largemouth bass comprised the largest percentage by number of fish harvested in strata A, B, C, D, E and H while crappie dominated strata F and G in total numbers of fish harvested in spring (Table 12). Estimated total numbers of fish harvested were based on the proportion of fish species measured in anglers' creels.

The most abundant length class of the largemouth bass measured in anglers' creels in winter was 15 inches TL while the most abundant length class of crappie was 14 inches TL. Largemouth and crappie measured in anglers' creels in the spring were generally 13 and 9 inches TL. Striped bass x white bass hybrids measured in anglers' creels in the spring were usually 18 inch TL. Length-frequency distributions of fish measured in anglers' creels in winter were plotted in Figures 9 through 12 and those measured in spring were plotted in Figures 13 through 17.

Anglers expended an estimated \$1.6 million on fuel, live bait, food and lodging while fishing Lake Hartwell in winter and spring, 1992. They spent most of their money (57%) on fuel. Fuel cost was estimated to be \$930,000 (Table 13). Anglers spent an additional estimated \$226,129 on fishing equipment. They also

Table 10. Catch-per-unit-effort (CPUE) (number released+ number harvested/angler-hour) and associated relative standard errors (RSE) for species targeted by anglers during winter and spring 1992 on Lake Hartwell.

<u>Target Species</u>	<u>Winter</u>		<u>Spring</u>	
	<u>CPUE</u>	<u>RSE</u>	<u>CPUE</u>	<u>RSE</u>
Anything	0	-	0	-
Bluegill			0.27	21
Crappie	0.12	-	0.55	-
Carp			0	-
Channel catfish	0	-	0	-
Largemouth bass	0.32	51	0.49	32
Spotted bass			0.21	-
Striped bass	0.04	29	0.08	48
Striped bass x white bass hybrids	0	-	0.29	32
Walleye	0	-		
White bass			0	-

Table 11. Number of fish (N), weight of fish (WT=lb) and percent composition (%) of fish species harvested based on the proportion of fish species measured in anglers' creels in winter 1992 on Lake Hartwell.

<u>Stratum</u>	<u>Species</u>	<u>N</u>	<u>%</u>	<u>WT</u>	<u>%</u>
A	----				
B	----				
C	----				
D	Largemouth bass	1,984	75	2,329	40
	Striped bass	661	25	3,549	60
E	Crappie	4,796	39	3,878	36
	Largemouth bass	2,585	22	4,237	34
	Redbreast sunfish	533	4	36	<1
	Yellow perch	1,066	9	232	2
F	----				
G	Crappie	389	7	149	2
	Largemouth bass	4,479	79	5,970	78
	Striped bass	195	3	453	6
	Striped bass x white bass hybrid	584	10	1,125	15
H	----				

Table 12. Number of fish (N), weight of fish (WT=lb) and percent composition (%) of fish species harvested based on the proportion of fish species measured in anglers' creels in spring 1992 on Lake Hartwell.

Stratum	Species	N	%	WT	%
A	Channel catfish	522	4	984	4
	Largemouth bass	5,741	48	8,960	33
	Striped bass	2,610	22	4,535	17
	Striped bass x white bass hybrid	3,131	26	12,504	46
B	Largemouth bass	2,043	47	4,220	60
	Redear sunfish	584	13	732	10
	Striped bass	875	20	1,050	15
	Striped bass x white bass hybrid	875	20	983	14
C	Channel catfish	277	2	106	<1
	Largemouth bass	5,808	51	11,403	40
	Spotted bass	553	5	157	1
	Striped bass x white bass hybrid	4,702	41	16,627	59
D	Bluegill sunfish	2,295	10	309	<1
	Largemouth bass	9,755	40	26,850	33
	Striped bass	4,017	17	11,922	15
	Striped bass x white bass hybrid	8,033	33	43,271	51
E	Bluegill sunfish	2,115	18	276	2
	Channel catfish	470	4	108	1
	Largemouth bass	2,585	22	4,237	34
	Redeye bass	470	4	219	2
	Redear sunfish	1,175	10	426	3
	Striped bass	1,410	12	786	6
	Striped bass x white bass hybrid	2,350	20	5,464	44
	White bass	940	8	1,010	8

Table 12 (cont.). Number of fish (N), weight of fish (WT=lb) and percent composition (%) of fish species harvested based on the proportion of fish species measured in anglers' creels in spring 1992 on Lake Hartwell.

<u>Stratum</u>	<u>Species</u>	<u>N</u>	<u>%</u>	<u>WT</u>	<u>%</u>
F	Crappie	7,583	59	2,543	38
	Largemouth bass	5,308	41	4,096	62
G	Bluegill sunfish	1,174	5	209	2
	Brown bullhead catfish	587	3	301	2
	Channel catfish	1,174	5	684	5
	Crappie	14,088	63	5,988	45
	Largemouth bass	3,522	16	4,599	35
	White bass	587	3	258	2
	White catfish	1,174	5	1,137	9
H	Crappie	1,746	34	1,016	16
	Largemouth bass	2,967	57	3,785	61
	Striped bass x white bass hybrid	350	7	1,385	22
	White bass	175	3	80	1

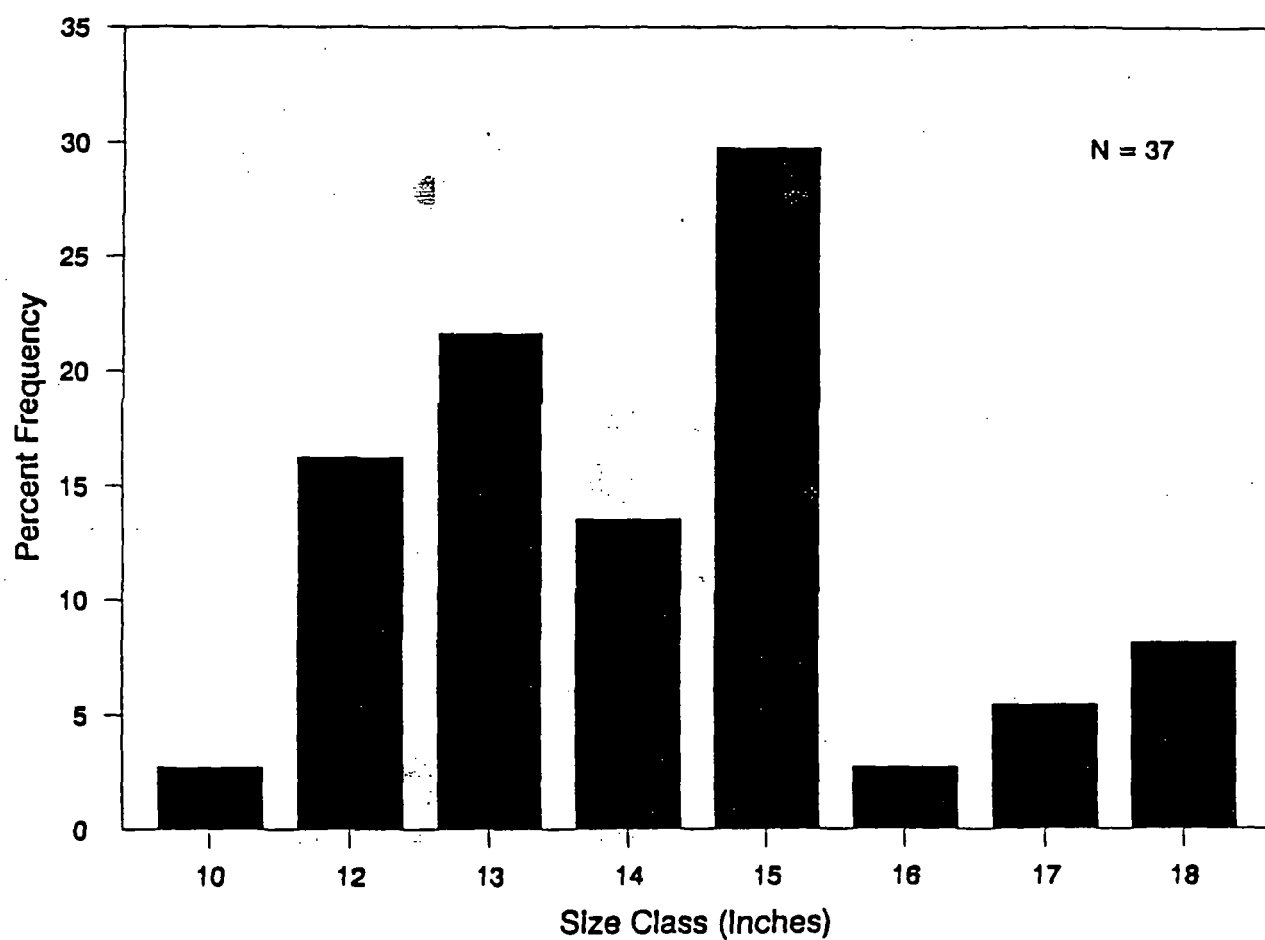


Figure 9. Length frequency distribution of largemouth bass measured in anglers' creel during winter 1992 on Lake Hartwell.

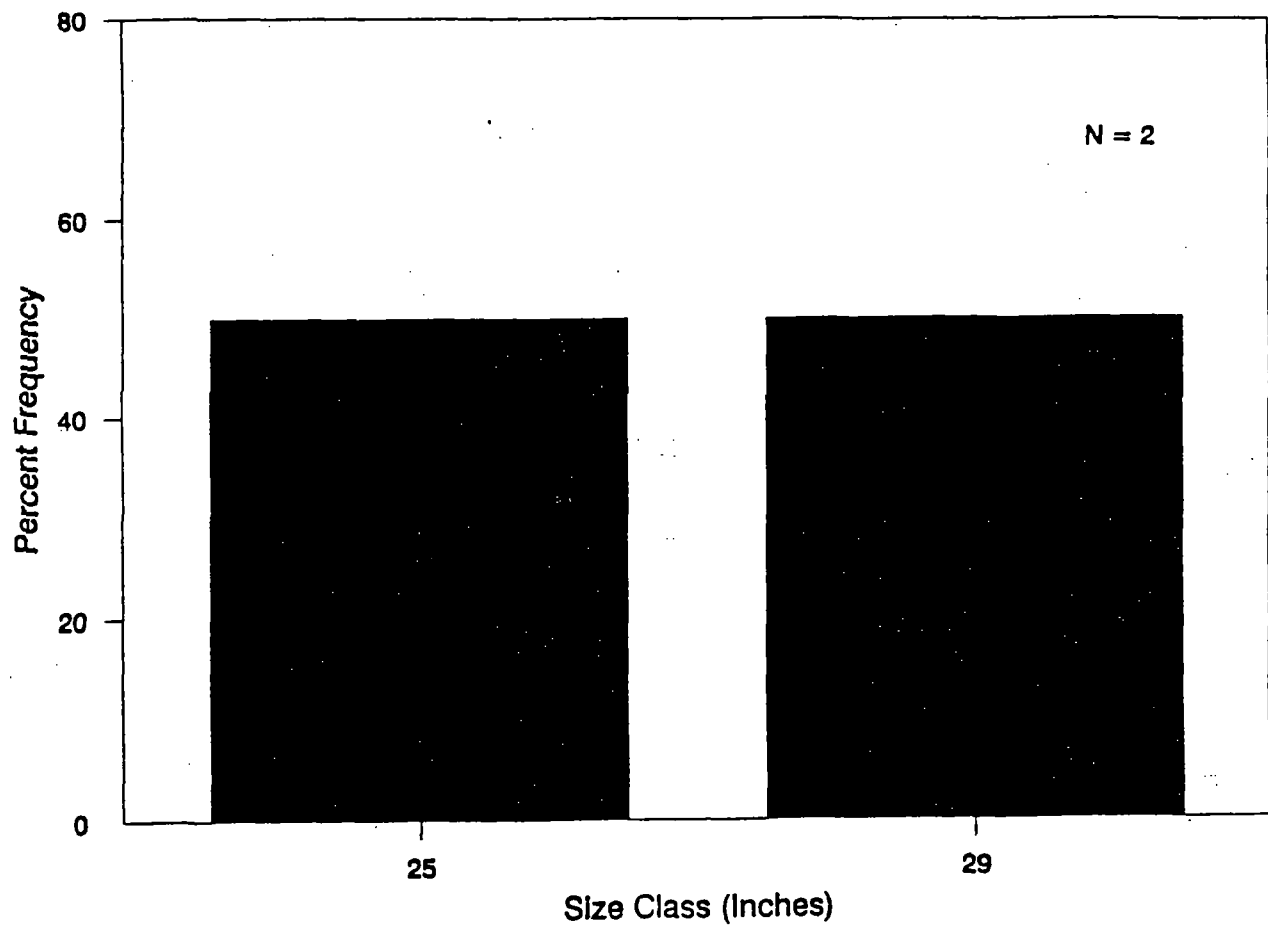


Figure 10. Length frequency distribution of striped bass measured in anglers' creels during winter 1992 on Lake Hartwell.

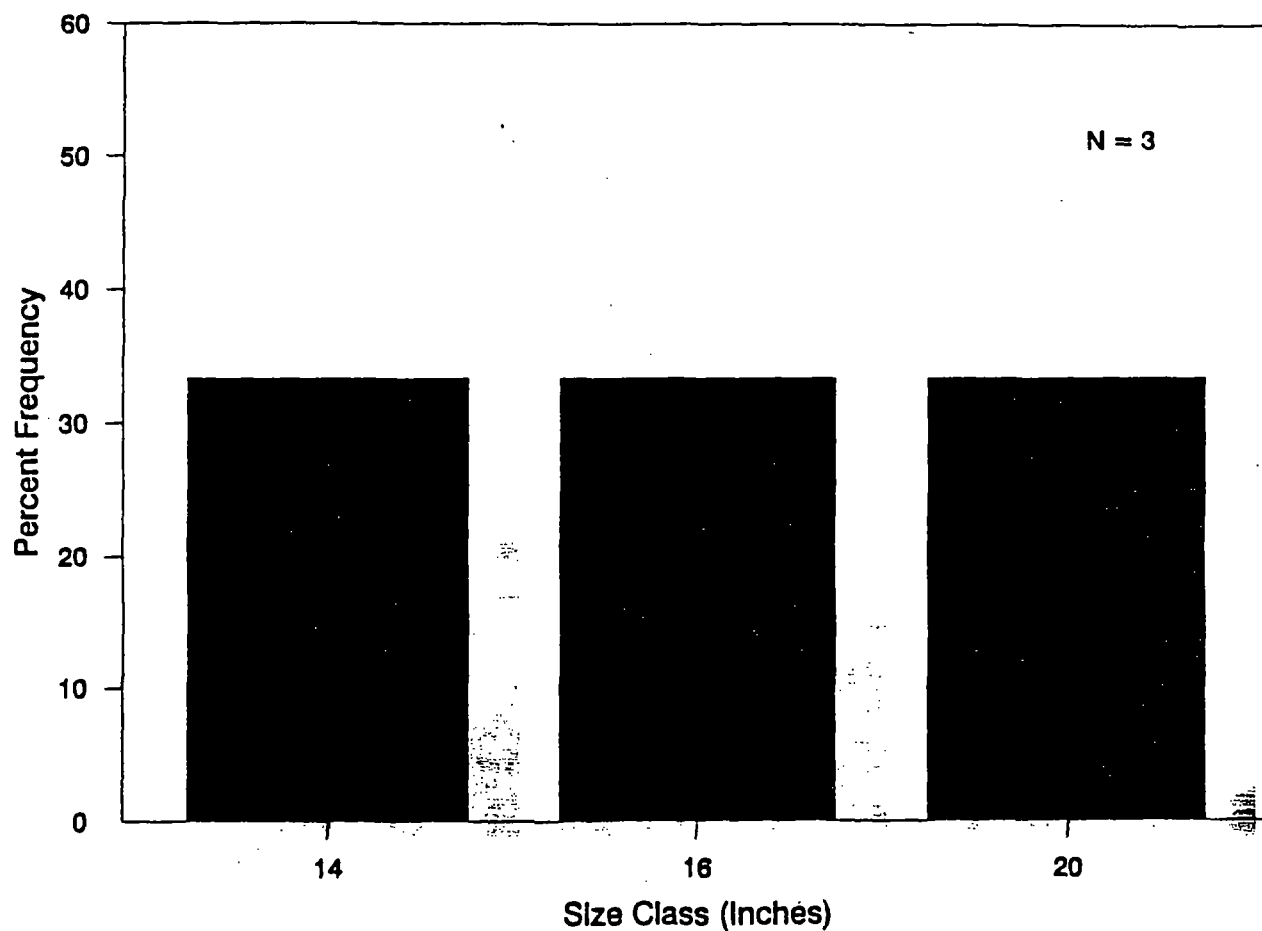


Figure 11. Length frequency distribution of striped bass x white bass hybrid measured in anglers' creels during winter 1992 on Lake Hartwell.

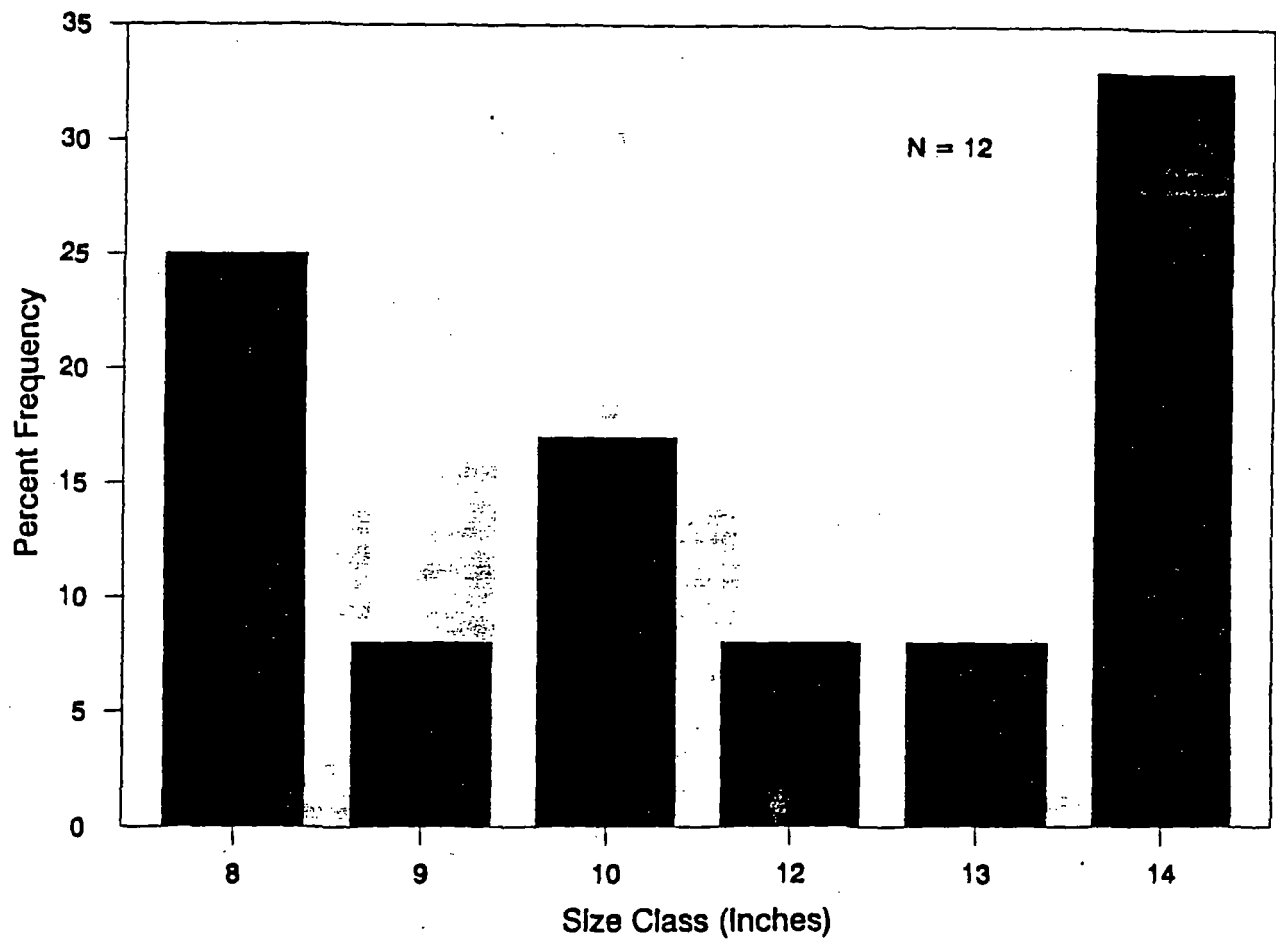


Figure 12. Length frequency distribution of black crappie and white crappie measured in anglers' creels during winter 1992 on Lake Hartwell.

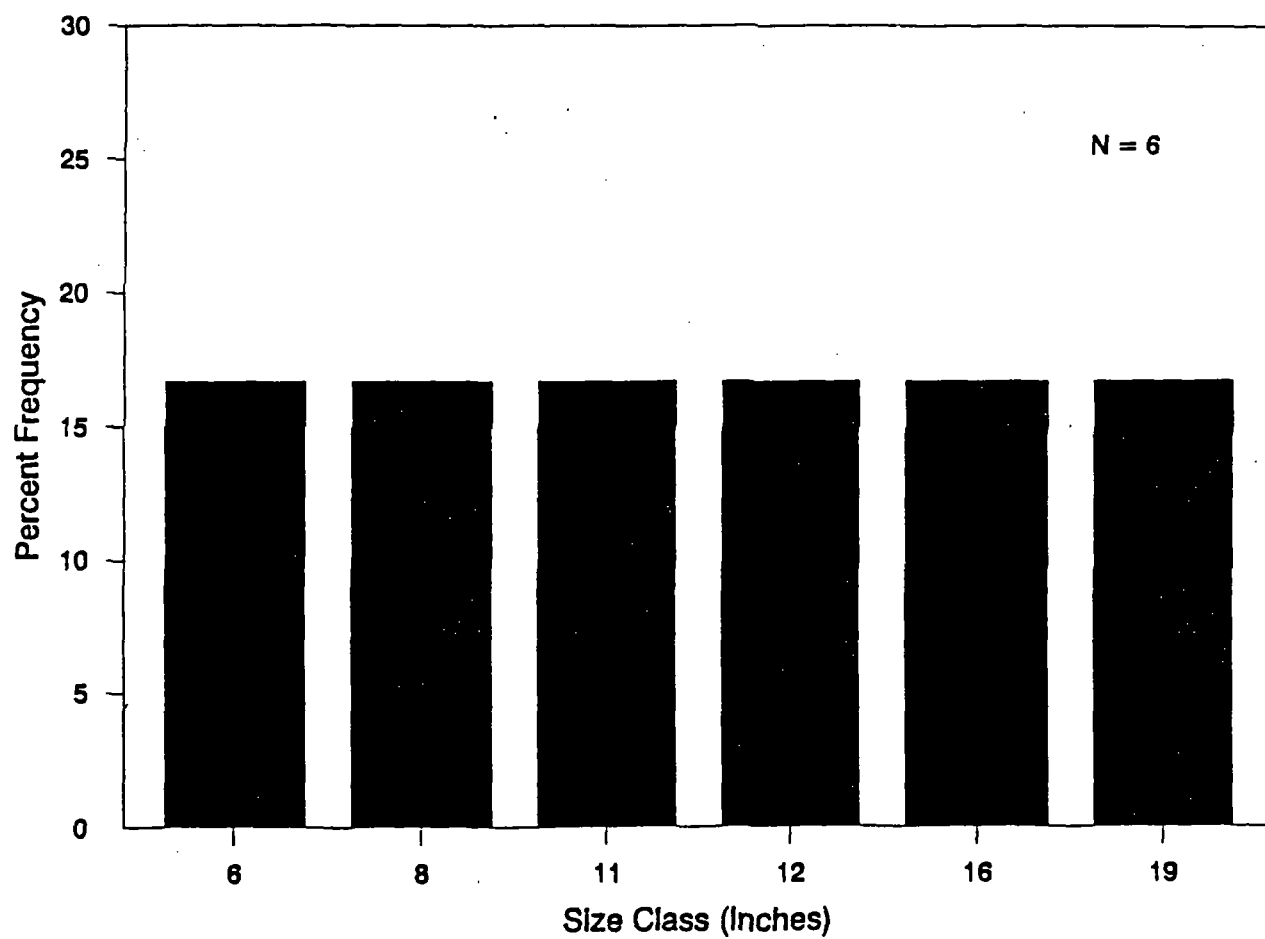


Figure 13. Length frequency distribution of channel catfish measured in anglers' creels during spring 1992 on Lake Hartwell.

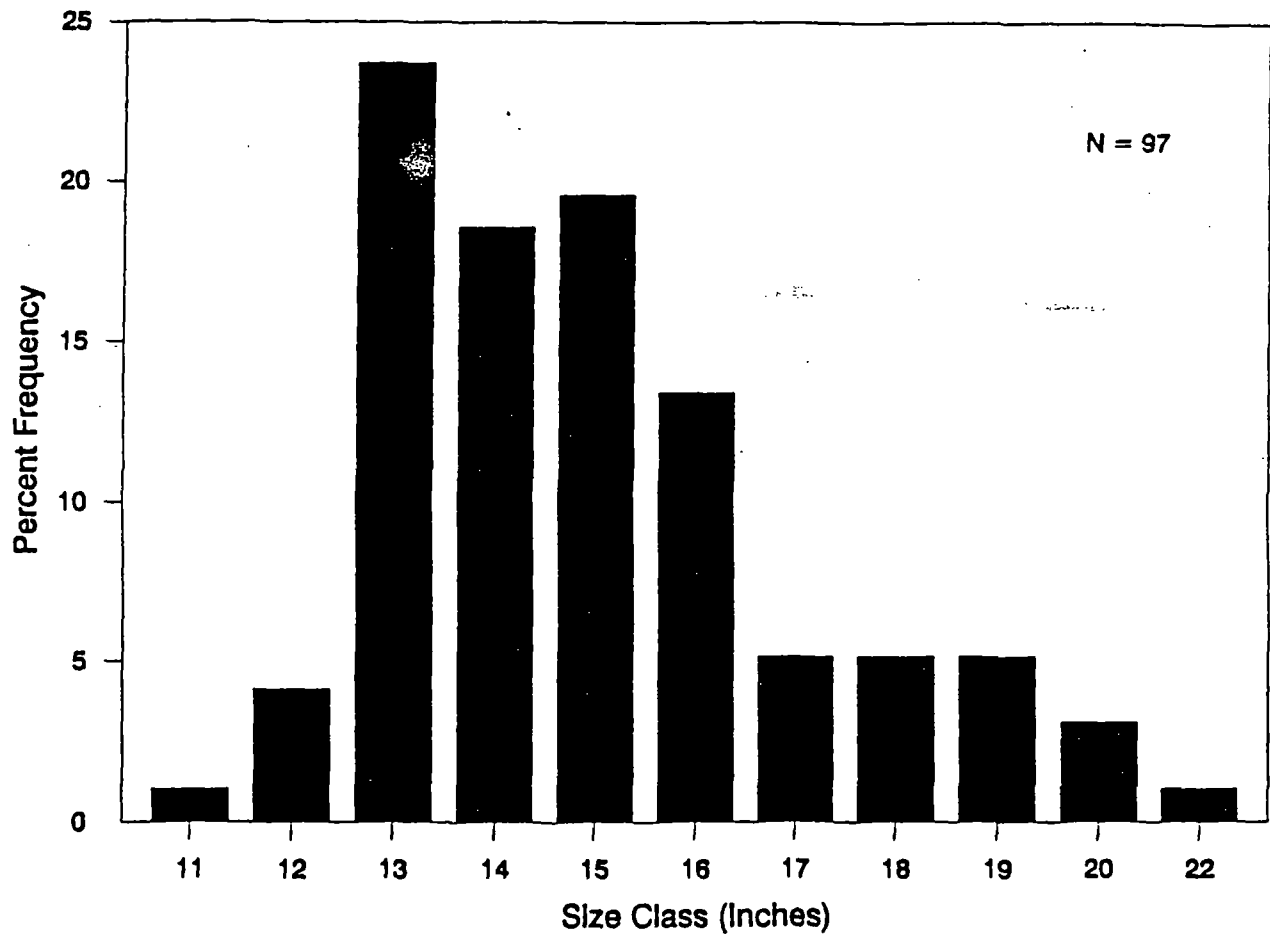


Figure 14. Length frequency distribution of largemouth bass measured in anglers' creels during spring 1992 on Lake Hartwell.

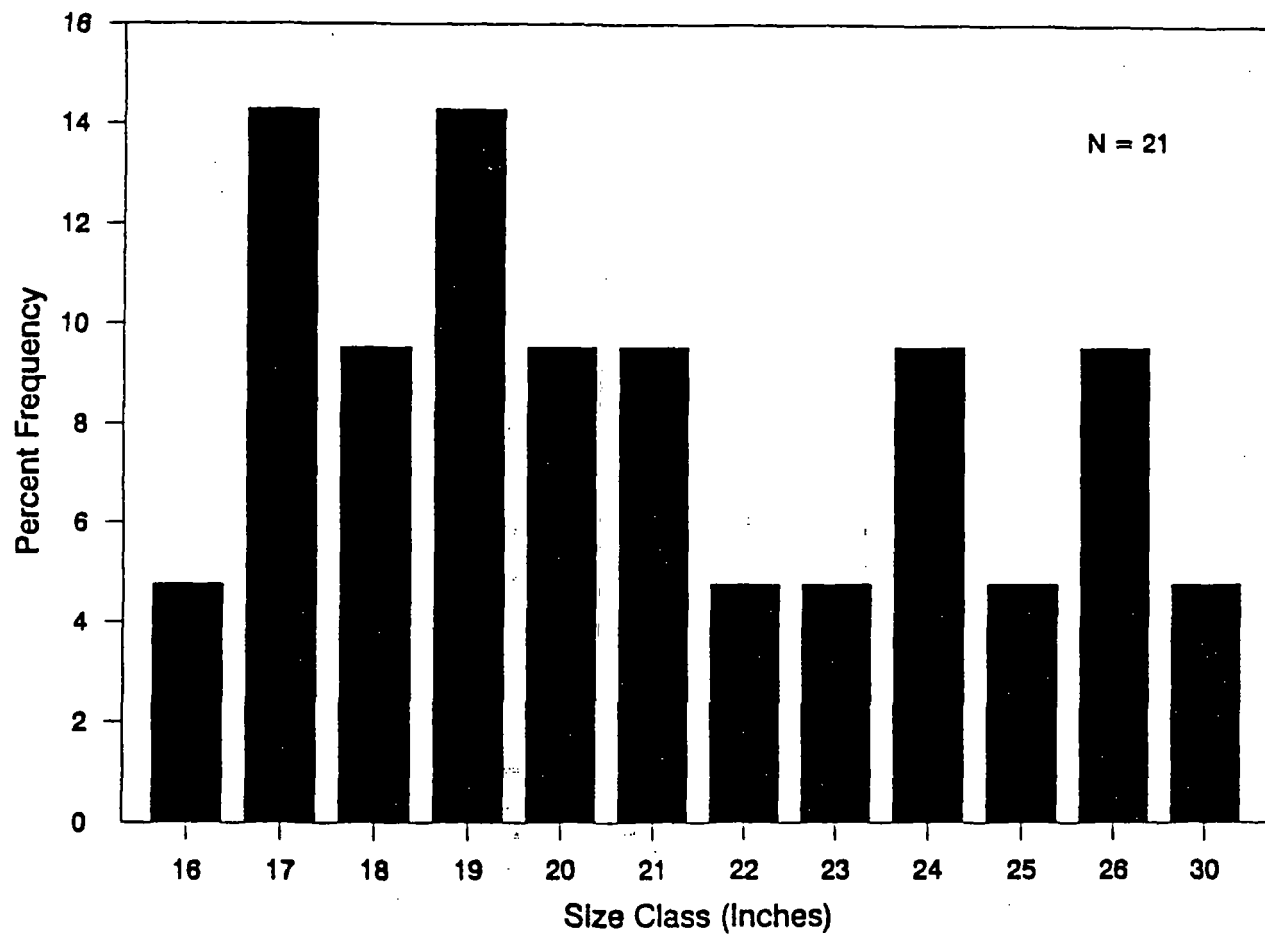


Figure 15. Length frequency distribution of striped bass measured in anglers' creels during spring 1992 on Lake Hartwell.

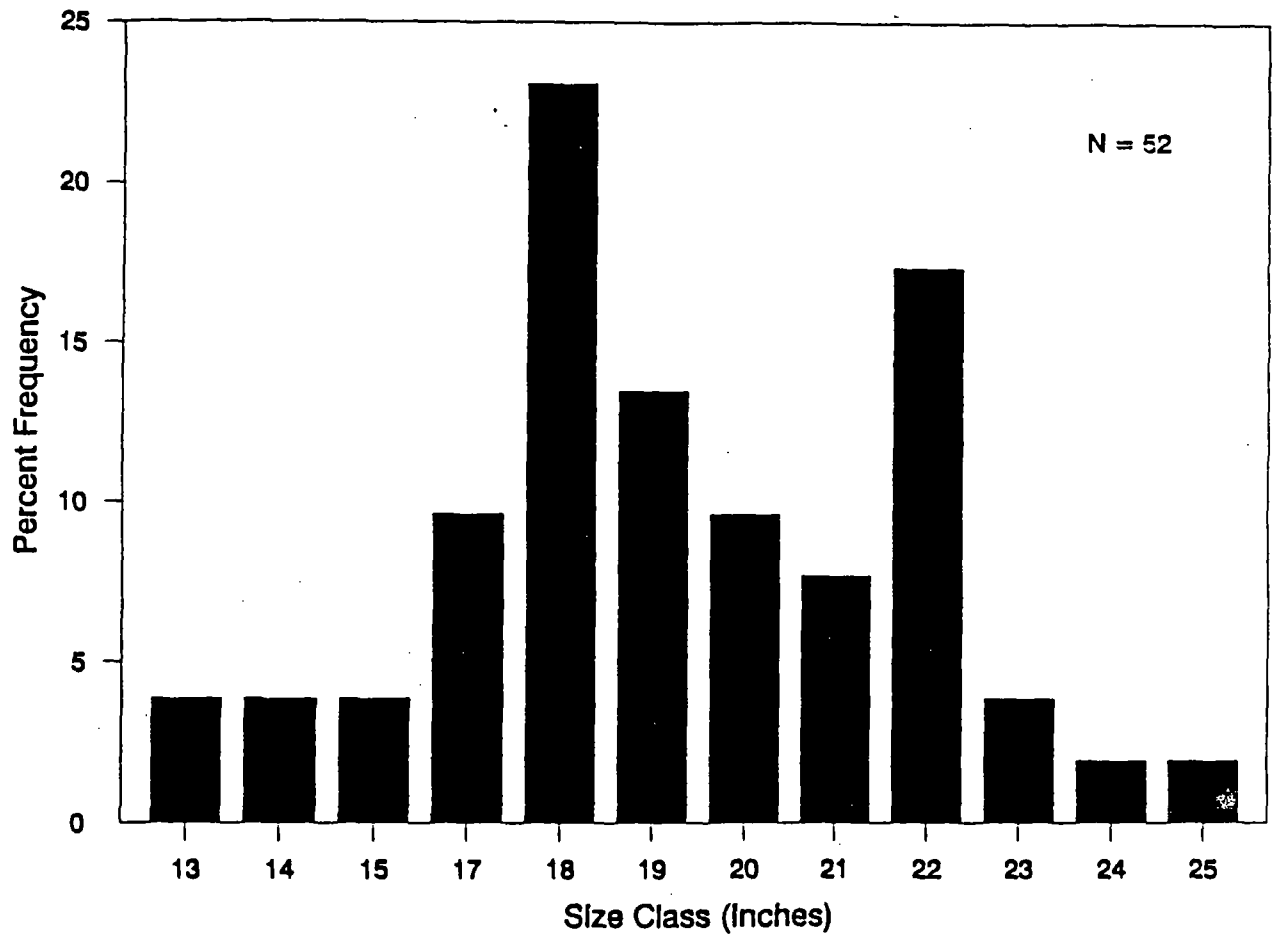


Figure 16. Length frequency distribution of striped bass x white bass hybrid measured in anglers' creels during spring 1992 on Lake Hartwell.

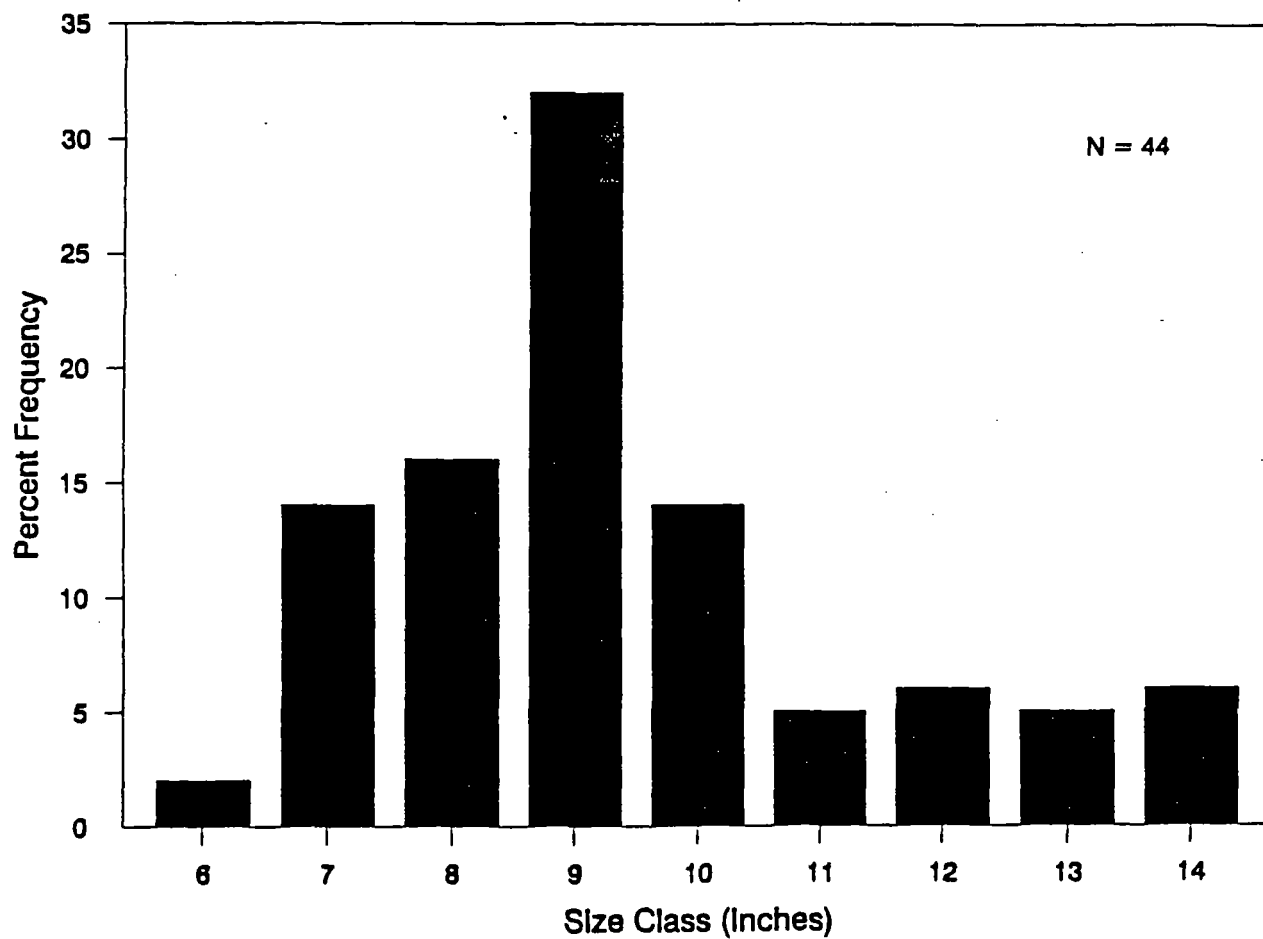


Figure 17. Length frequency distribution of black crappie and white crappie measured in anglers' creels during spring 1992 on Lake Hartwell.

Table 13. Estimated anglers' expenditures (\$) on fuel, live bait, food and lodging while fishing Lake Hartwell during winter and spring 1992.

<u>Time</u>	<u>Fuel</u>	<u>Live Bait</u>	<u>Food</u>	<u>Lodging</u>	<u>Total</u>
Winter	256,717	68,022	71,703	0	396,441
Spring	<u>672,798</u>	<u>128,956</u>	<u>295,734</u>	<u>136,210</u>	<u>1,233,698</u>
Total	\$929,515	196,978	367,437	136,210	1,630,139

indicated they would be willing to spend a total of \$1.4 million more if necessary to fish Lake Hartwell.

Sixty-six percent of those anglers interviewed in winter and spring 1992 were South Carolina residents while 34% were non-residents. Non-residents appeared to frequent strata G and H, the Tugaloo River arm of Lake Hartwell (Figure 18). Eighty-five percent of anglers interviewed were aware of the current health advisory on Lake Hartwell. Anglers not aware of the advisory ($\geq 24\%$) appeared to frequent strata A, G and H (Table 14).

Sixty-six percent of anglers interviewed indicated they ate fish they caught from Lake Hartwell. Stratum F had the lowest percentage (38%) of anglers who ate fish they caught from Lake Hartwell (Table 15). Fourteen percent of those anglers interviewed indicated the health advisory had stopped them from eating fish from Lake Hartwell; 86% offered scenarios that would stop them from eating fish or indicated reasons other than the health advisory that had stopped them from eating fish from Lake Hartwell (Table 16).

Fourteen percent of the anglers that chose to respond commented that a stronger advisory/warning would stop them from eating fish from Lake Hartwell (Table 17). Estimated mean per capita consumption of fish from Lake Hartwell was 0.25 lbs. for winter (RSE=48) and 5.44 lbs. for spring (RSE=25). Mean per capita consumption of fish increased in all lake strata from winter to spring. The highest mean per capita consumption rate

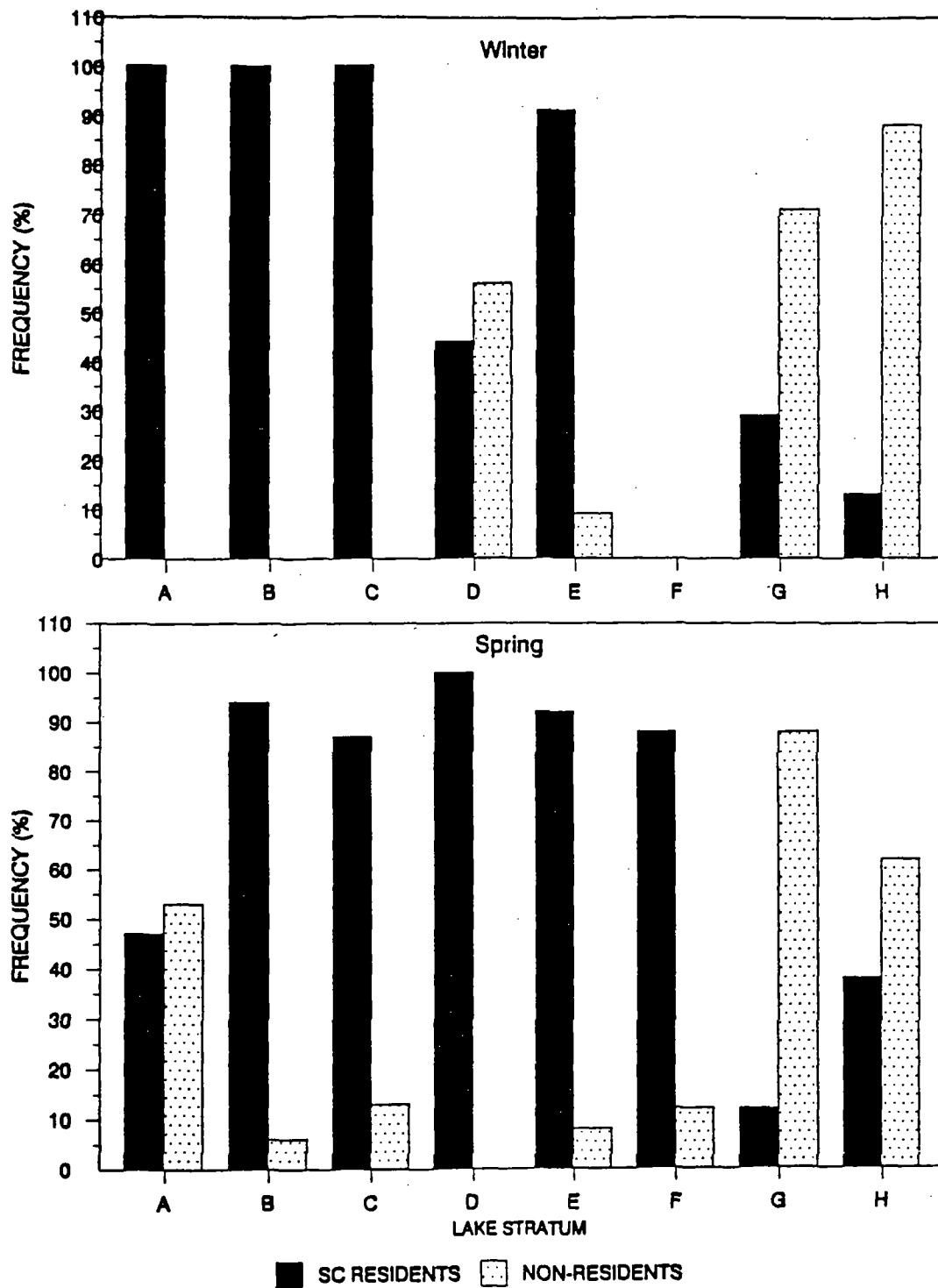


Figure 18. Frequency of In-state (S.C.) and out-of-state anglers interviewed in each stratum in winter and spring 1992 on Lake Hartwell.

Table 14. Total number (N) and the percentage (%) of anglers interviewed in each stratum that were aware of the health advisory on Lake Hartwell in winter and spring 1992.

<u>Stratum</u>	Aware		Not Aware	
	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>
A	22	67	11	33
B	20	100		
C	26	76	8	24
D	39	98	1	2
E	43	100		
F	18	86	3	14
G	35	76	11	24
H	<u>15</u>	<u>75</u>	<u>5</u>	<u>25</u>
Total	218	85	39	15

Table 15. Total number (N) and the percentage (%) of anglers interviewed in winter and spring 1992 in each stratum that ate the fish they caught from Lake Hartwell.

<u>Stratum</u>	<u>Eat Fish</u>		<u>Not Eat Fish</u>	
	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>
A	29	88	4	18
B	15	75	5	25
C	21	62	13	38
D	31	78	9	22
E	22	51	21	49
F	8	38	13	62
G	28	64	16	36
H	<u>22</u>	<u>73</u>	<u>8</u>	<u>27</u>
Total	176	66	89	34

Table 16. Total number (N) and the percentage (%) of anglers interviewed in winter and spring 1992 in each stratum that stopped eating fish caught from Lake Hartwell because of the health advisory or other reasons that had stopped them or would stop them from eating fish caught from Lake Hartwell.

<u>Stratum</u>	Advisory		Other	
	<u>N</u>	<u>%</u>	<u>N</u>	<u>%</u>
A	2	6	30	94
B	3	15	17	85
C	8	24	26	76
D	3	5	37	95
E	7	20	28	80
F	5	24	16	76
G	6	15	34	85
H	<u>2</u>	<u>7</u>	<u>28</u>	<u>93</u>
Total	36	14	216	86

Table 17. Responses of anglers interviewed during winter and spring 1992 on what it would take to make them stop eating fish caught from Lake Hartwell or why they had stopped eating fish caught from Lake Hartwell.

<u>Responses</u>	<u>N</u>	<u>%</u>
A stronger advisory/warning	33	14.4
Total ban on fish consumption	26	11.4
Increased contamination (PCBs, nuclear, Mercury, Dioxin, etc.)	26	11.4
Get sick/see people get sick	24	10.4
Nothing	17	7.4
Further designate a fish size and/or location	14	6.1
Don't know	13	5.7
If they didn't catch any fish	13	5.7
Unhealthy looking fish (sores, deformities, etc.)	10	4.4
If someone died from eating fish	7	3
Dumping of raw sewage into Lake Hartwell	5	2.1
Seeing dead fish on the lake	1	<1
'Don't eat fish from Lake Hartwell	18	7.9
'Catch and release only	<u>22</u>	<u>9.6</u>
Total	229	100

* Anglers that indicated they did not eat fish from Lake Hartwell

in spring was observed in stratum D (15.1 lbs, RSE=13) and the lowest in stratum C (0.38 lbs, RSE=100) (Table 18).

Twelve Mile Creek

Data for the Twelve Mile Creek creel survey were compiled monthly January through August 1992. A total of 21 interviews were conducted during the eight month period. Anglers exerted a total of 1,412 angler-hours of effort on Twelve Mile Creek (RSE=49). The highest angler effort occurred in April (Figure 19). Average daily rates (per angler hour) of the number of fish caught, number of fish released, number of fish harvested and the weight (lbs) of fish harvested averaged 0.49, 0.12, 0.37 and 0.24, respectively. Catch and harvest rates were highest in August, however data consisted of only two interviews (Table 19).

A total of 815 fish were caught (RSE=111). Of these, 226 fish were released (RSE=109), and 589 fish (RSE=122) weighing 256 lbs (RSE=122) were harvested. Most fish were harvested in April and June; no data were available for January and February since no anglers were interviewed (Table 20). Sixty-seven percent of angler effort was directed toward any fish species, 20% toward channel catfish, 8% toward bluegill, 4% toward largemouth bass and 1% toward crappie. Effort directed toward individual species is listed for each month in Table 21.

Channel catfish comprised the highest percentage by number and weight (lbs) of fish harvested from Twelve Mile Creek (32 and

Table 18. Average per capita consumption (lbs) of fish from Lake Hartwell and their associated relative standard errors (RSE) for each lake stratum in winter and spring 1992.

<u>Stratum</u>	<u>Winter</u>		<u>Spring</u>	
	<u>Per Capita Consumption</u>	<u>RSE</u>	<u>Per Capita Consumption</u>	<u>RSE</u>
A	0	-	5.19	56
B	0	-	0.38	-
C	0	-	0.27	100
D	0	-	15.1	13
E	2.01	48	5.41	79
F	0	-	1.12	-
G	0	-	6.21	87
H	<u>0</u>	<u>-</u>	<u>9.86</u>	<u>76</u>
Mean	0.25	48	5.44	25

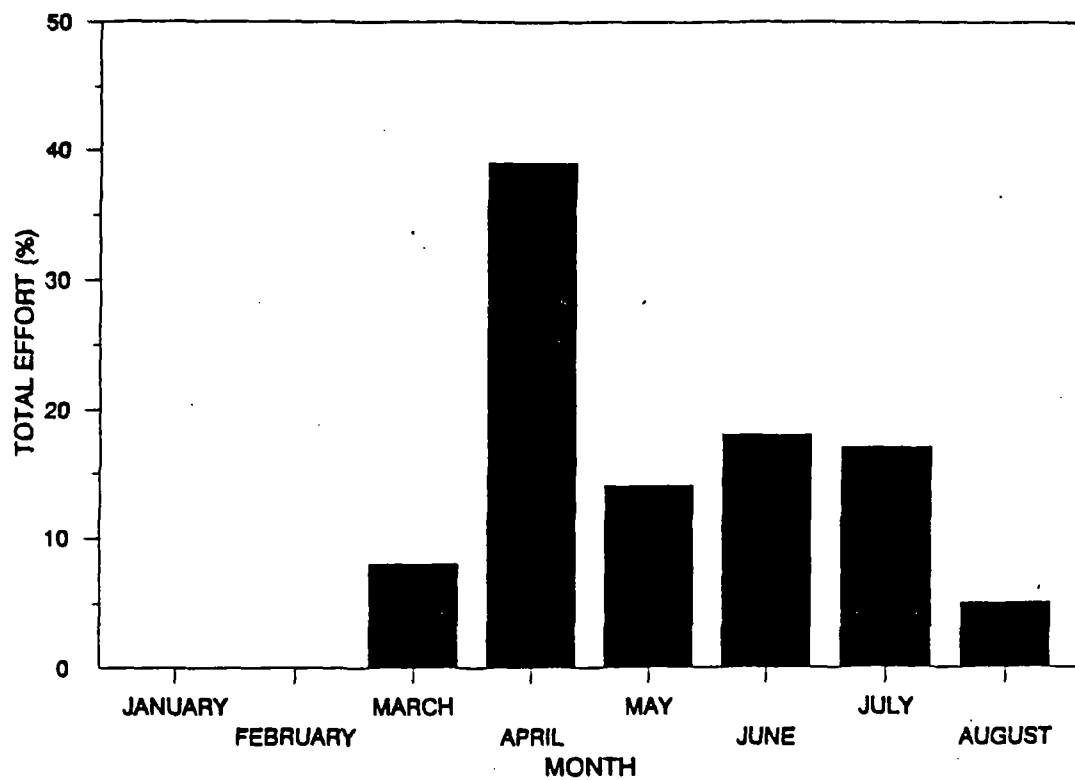


Figure 19. Percentage of total angler effort (angler-hours) for each month of the 1992 Twelve Mile Creek roving creel survey.

Table 19. Average daily rates (per angler-hour) of number of fish caught and released (C/R), number of fish caught (CATCH), number of fish harvested (HARV) and weight of fish harvested (WT) and associated relative standard errors (RSE) for each month (January-August) of the 1992 Twelve Mile Creek creel survey.

<u>Month</u>	<u>C/R</u>	<u>RSE</u>	<u>CATCH</u>	<u>RSE</u>	<u>HARV</u>	<u>RSE</u>	<u>WT</u>	<u>RSE</u>
January	0	-	0	-	0	-	0	-
February	0	-	0	-	0	-	0	-
March	0.09	-	0.39	-	0.29	-	0.09	-
April	0.15	71	0.48	71	0.33	71	0.08	71
May	0	-	0	-	0	-	0	-
June	0.36	71	1.33	71	0.98	71	0.35	71
July	0.11	71	0.28	71	0.17	71	0.07	71
August	0.23	-	1.45	-	1.22	-	1.31	-

Table 20. Estimated total number of fish released (REL), total number of fish harvested (HARV), total weight harvested (lbs) (WT), total catch (number released+number harvested) and associated relative standard errors (RSE) for January-August 1992 on Twelve Mile Creek.

<u>Month</u>	<u>REL</u>	<u>RSE</u>	<u>HARV</u>	<u>RSE</u>	<u>WT</u>	<u>RSE</u>	<u>Catch</u>	<u>RSE</u>
January	0	-	0	-	0	-	0	-
February	0	-	0	-	0	-	0	-
March	11	-	31	-	10	-	42	-
April	82	82	179	82	46	82	261	82
May	0	-	0	-	0	-	0	-
June	91	112	251	112	89	112	343	112
July	25	100	40	100	16	100	65	61
August	<u>16</u>	<u>-</u>	<u>88</u>	<u>-</u>	<u>95</u>	<u>-</u>	<u>104</u>	<u>-</u>
Total	225	109	589	122	256	169	815	111

Table 21. Distribution of directed angler effort (angler-hours) toward target species on Twelve Mile Creek from January-August 1992.

<u>Month</u>	<u>Target Species</u>	<u>Hours</u>	<u>%</u>
January	---		
February	---		
March	Channel catfish	108	100
April	Anything	477	87
	Bluegill	7	1
	Crappie	13	2
	Largemouth bass	52	10
May	Anything	190	99
	Channel catfish	2	1
June	Anything	51	20
	Bluegill	103	40
	Channel catfish	103	40
July	Anything	234	100
August	Channel catfish	72	100

47%). Bluegill and redbreast sunfish were second and third in percent composition by number (31 and 19%) (Table 22). The number and weight (lbs) of species harvested each month is summarized in Table 23. Length frequency distributions of fish measured in anglers' creels were not plotted due to small sample size.

Anglers spent an estimated \$8,371 on fuel, live bait, food and lodging while fishing on Twelve Mile Creek. Anglers spent an additional estimated \$696 on fishing equipment and were willing to spend an extra \$8,828 to fish Twelve Mile Creek (Table 24). All anglers interviewed were South Carolina residents, all were aware of the current health advisory and 56% ate fish they caught from Twelve Mile Creek.

Two percent of anglers interviewed indicated they had stopped eating fish because of the health advisory; 88% listed other reasons that would stop them or that had already stopped them from eating fish from Twelve Mile Creek (Table 25). Anglers who ate fish from Twelve Mile Creek consumed an average of 2.81 lbs of fish per capita per month for a total of 22.5 lbs per capita (RSE=69) for the eight-month period (Table 26).

Discussion

Total fishing effort on Lake Hartwell during winter and spring (487,723 angler-hours), was similar to fishing effort estimated during these seasons when the last creel survey was

Table 22. Total number (N), total weight (lb) and associated percentages of fish harvested from Twelve Mile Creek from January-August 1992.

<u>Species</u>	<u>N</u>	<u>%</u>	<u>Wt</u>	<u>%</u>
Bluegill	176	31	20	9
Brown bullhead catfish	20	4	9	4
Channel catfish	181	32	108	47
Largemouth bass	52	9	64	28
Redbreast sunfish	109	19	26	11
Yellow bullhead catfish	10	2	-	-
Yellow perch	23	4	4	2

Table 23. Total number (N), total weight (lb) and associated percentages of fish harvested from Twelve Mile Creek for each month of the study period (January-August).

<u>Month</u>	<u>Species</u>	<u>N</u>	<u>%</u>	<u>Wt</u>	<u>%</u>
January	---				
February	---				
March	Bluegill	11	33	1	13
	Channel catfish	21	67	9	87
April	Bluegill	119	67	6	14
	Channel catfish	40	22	15	33
	White bass	20	11	24	52
May	---				
June	Bluegill	46	18	13	15
	Channel catfish	91	36	52	58
	Largemouth bass	23	9	10	11
	Redbreast sunfish	69	27	10	11
	Yellow perch	23	9	4	5
July	Redbreast sunfish	40	100	16	100
August	Brown bullhead catfish	20	22	9	10
	Channel catfish	29	33	32	33
	Largemouth bass	29	33	54	57
	Yellow bullhead catfish	10	11	-	-

Table 24. Estimated anglers' expenditures (\$) on fuel, live bait, food and lodging while fishing Twelve Mile Creek from January-August 1992.

<u>Month</u>	<u>Fuel</u>	<u>Live Bait</u>	<u>Food</u>	<u>Lodging</u>	<u>Total</u>
January	0	0	0	0	0
February	0	0	0	0	0
March	744	0	446	0	1,190
April	386	535	245	0	1,167
May	509	262	0	0	771
June	543	769	494	0	1,807
July	1,264	579	833	289	2,964
August	<u>287</u>	<u>93</u>	<u>93</u>	<u>0</u>	<u>472</u>
Total	\$3,733	2,238	2,111	289	8,371

Table 25. Responses of anglers interviewed on what it would take to make them stop eating fish caught from Twelve Mile Creek or why they had stopped eating fish caught from Twelve Mile Creek.

<u>Responses</u>	<u>N</u>	<u>%</u>
A stronger advisory/warning	1	5
Total ban on fish consumption	1	5
Increased contamination (PCBs, nuclear, Mercury, Dioxin, etc.)	2	12
Nothing	2	12
If they didn't catch any fish	2	12
Unhealthy looking fish (sores, deformities, etc.)	2	12
If someone died from eating fish	2	12
'Don't eat fish	<u>5</u>	<u>30</u>
Total	17	100

' Anglers that indicated they did not eat fish from Twelve Mile Creek

Table 26. Average per capita consumption (lbs) of fish from Twelve Mile Creek and the associated relative standard errors (RSE) for months January-August 1992.

<u>Month</u>	<u>Average Per Capita Consumption</u>	<u>RSE</u>
January	0	-
February	0	-
March	1.43	-
April	2.79	35
May	0	-
June	16.9	69
July	1.37	-
August	<u>0</u>	<u>-</u>
Mean	2.81	69

conducted in 1989. Angler effort in winter and spring on Lake Hartwell appeared to be concentrated in stratum A, C, F and G. In winter, boat anglers were most frequently encountered in all strata, however in spring, bank anglers were equally as frequent or more frequent in some areas. More temperate weather was thought to have some influence on the increased frequency of bank anglers and the high degree of bank anglers may have reflected increased use by subsistence anglers.

Catch rates generally increased from winter to spring. . Catch rates across all eight strata for all fish species combined were similar during spring. Anglers appeared to target largemouth bass and crappie although effort toward striped bass x white bass hybrids increased eight-fold in spring over winter. Largemouth bass and crappie generally comprised the largest percentage of fish harvested by number and weight based on the proportion of fish species measured in anglers' creels in winter and spring.

Anglers who frequented strata G and H were generally non-residents of South Carolina and more out-of-state anglers were observed in stratum A in spring than in winter. These strata proximity to the state of Georgia were thought to have caused this imbalance in angler residency. More out-of-state anglers were observed in stratum D in winter, however only resident anglers were encountered there in spring.

Most anglers appeared to be aware of the health advisory

currently in effect. Those not aware of the advisory appeared to frequent those strata nearest the Georgia side of Lake Hartwell where no warning signs are currently posted. Although most of the anglers interviewed were aware of the health advisory, most continued to eat the fish they caught from Lake Hartwell. No pattern was evident in the spatial differences in fish consumption as was evident in the awareness responses. For example, anglers who frequented stratum D had the highest frequency of advisory awareness, however, the second highest percentage of anglers who ate fish they caught from Lake Hartwell were interviewed in this area.

The health advisory on fish consumption had appeared to influence consumptive habits of less than one-fourth of those anglers interviewed. Most cited other reasons that had stopped them from eating fish caught from Lake Hartwell. A stronger advisory, a total ban on fishing and documentation of increased contamination appeared to be the three main factors that anglers responded would effect their fish consumption habits.

The magnitude of per capita fish consumption estimates were the first collected from Lake Hartwell, therefore no comparisons were made to previous consumptive habits of anglers that fished there. Fish consumption creel data, collected in Alabama, are currently being compiled by FIMS (pers. comm.). The Alabama data can be compared to Lake Hartwell consumption results to detect relative trends in per capita fish consumption rates in the

southeastern United States once the Lake Hartwell creel survey is completed.

Angler use of Twelve Mile Creek appeared to be very limited. Anglers most frequented the two lower access points that were nearest the confluence of Twelve Mile Creek with Lake Hartwell. Catch rates of all fish species were highest in June and August, however the sample sizes were very small, subsequently the RSEs were extremely high. Channel catfish were the most sought after fish species and they comprised the greatest percentage harvested by weight. Notably, redbreast sunfish, which were surveyed in spring 1992 throughout the Twelve Mile Creek drainage by SCWMRD, were third in percent total weight of fish harvested.

About one-third of the anglers that fished Twelve Mile Creek did not eat fish they caught there. A few of the anglers interviewed were interviewed more than one time which indicated there may be localized subsistence fishing on Twelve Mile Creek. The per capita fish consumption estimates were lower for Twelve Mile Creek than for Lake Hartwell probably due to lower levels of angler effort on Twelve Mile Creek.

Conclusion

Preliminary results indicated angler effort increased from winter to spring on Lake Hartwell. Out-of-state anglers frequented strata A, G and H on Lake Hartwell. Anglers most frequently targeted largemouth bass and crappie, however angler

effort increased for striped bass x white bass hybrids in spring. Most anglers were aware of the current health advisory on fish consumption yet most anglers continued to consume the fish they caught from Lake Hartwell.

Limited angler use of Twelve Mile Creek was observed over the eight-month period. Anglers generally targeted channel catfish. All anglers interviewed were S.C. residents and most did not consume the fish they caught from Twelve Mile Creek. Some anglers were interviewed more than once which indicated there may be a small, localized group of subsistence anglers that frequent Twelve Mile Creek.

Data from the Lake Hartwell and Twelve Mile Creek creel surveys are still being collected and will continue through December 1992. Annual trends in temporal and spatial angler use of these fisheries and annual fish consumption habits cannot be quantified until the surveys are complete.

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